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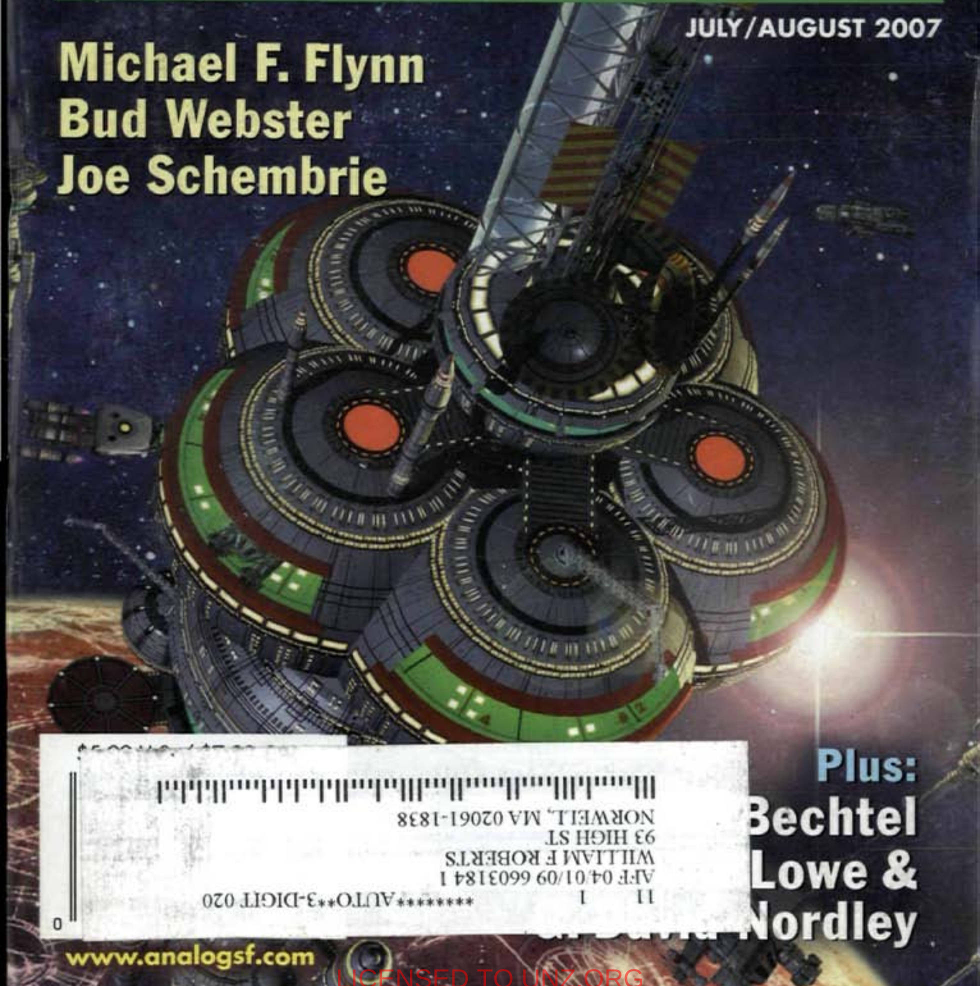

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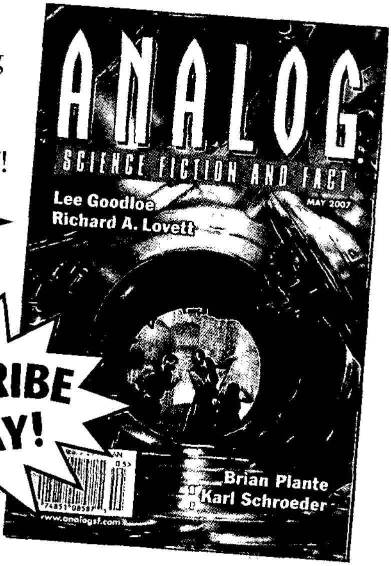

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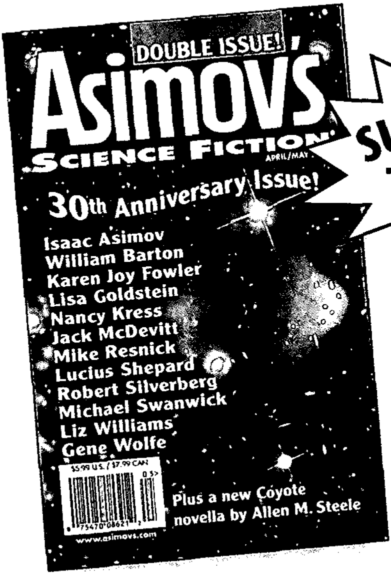

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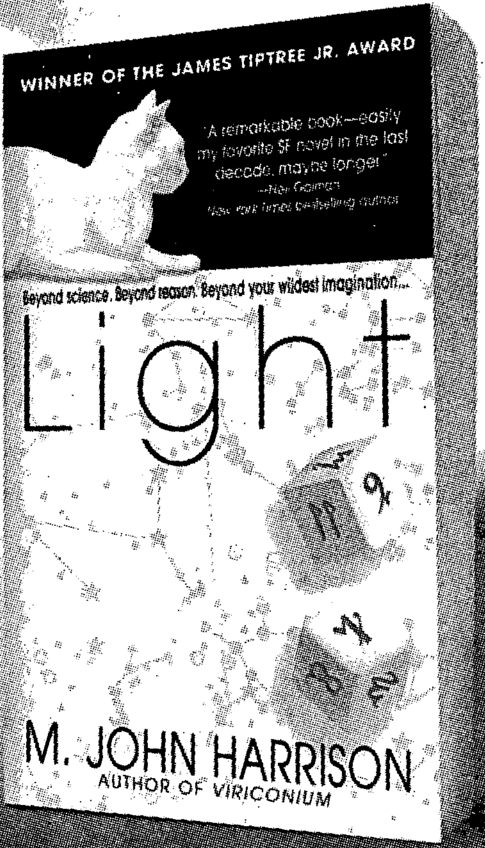
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EDITORIAL Stanley Schmidt

THE CAPACITY OF DREAMS

A device that has often figured in science fiction, and many of us have sometimes thought we'd like to have in reality, is a dream recorder. In Kristine Kathryn Rusch's "Paparazzi of Dreams" (*Analog*, November 2004), for example, recorded dreams are a profitable form of entertainment—and surreptitiously recorded dreams of celebrities even more so. Other possible uses, some of them more benign (but all subject to misapplication), might be found in research (e.g., about dreams themselves and their relationship to the "external" world), psychotherapy, and forensics.

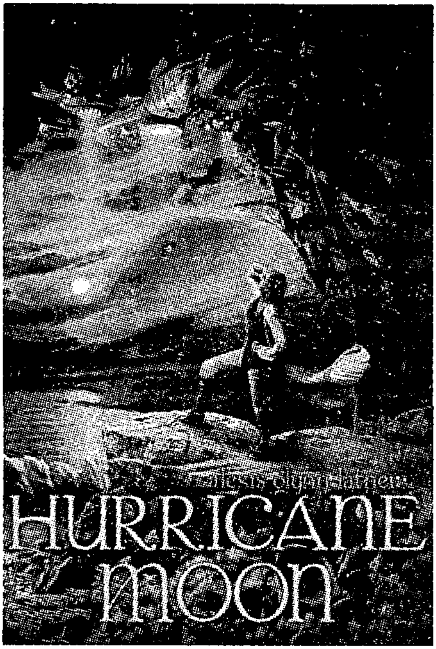
But what would the technical requirements for such a device be? I don't intend to try to guess at all of them. The logistical details of getting the necessary information out of one brain and into another are probably a thorny problem in themselves. But I do have some purely speculative thoughts on one aspect of the problem: How much information storage would we need? And even if we had it, would it really be adequate to do what we want?

It's not as simple a question as it might seem, and I'm not going to come up with any exact numbers and claim they're correct. But I can make some semi-quantitative guesses about what the problem might involve. We might start by considering the dream just as a series of pictures, and considering the data requirements of a digital camera. Most people think a 3-megapixel picture looks good, as long as they don't blow it up too much, but for big enlargements most professionals would want at least 10 megapixels. Even that can't match the detail of fine-grain large-format film, but that's not an intrinsic difference between film and digital photography; at the rate data storage technology is evolving, it won't be long before sharpness is a non-issue in choosing between the two media.

How sharp an image would you need to reproduce a dream to anybody's satisfaction? Probably most people have had dreams that seemed so real that they weren't sure whether they were dreaming or awake. That would seem to imply a pretty high-quality picture, so perhaps that 3-megapixel figure approximates a minimum (though I have reservations about that to which I'll return later).

How many *bytes* that requires depends on how much information you need to record about each pixel. If you only need a black-and-white picture, you don't need as much information as if you want to specify a full range of colors. And that leads us to something that has long puzzled me about people's accounts of their own dreams. I have heard some people say they always dream in black-and-white. I have also heard people—sometimes the same people—say that a dream was so vivid they thought it was real. How can a person with normal color vision hold both these views? Since we always see the real world in color (except under abnormally poor lighting conditions), it seems to me that dreaming in black-and-white

HURRICANE MOON



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would be a dead giveaway that what was being experienced was not ordinary reality.

So my suspicion is that most people normally dream in color, and those who think they dream in black-and-white think so only because dreams normally fade from memory very soon after awakening, and the memory of color is the first part to go. Personally, I know that my dreams are always quite colorful. (With one conspicuous and perhaps humorous exception. I once had a lucid dream—one in which I knew I was dreaming—during which I thought about this paradox. Since I normally dream in color, I wondered what it would be like to dream in black-and-white—so I switched the color off, and then back on. I toggled back and forth several times between color and black-and-white, then settled back into color to rejoin my normal program, already in progress.)

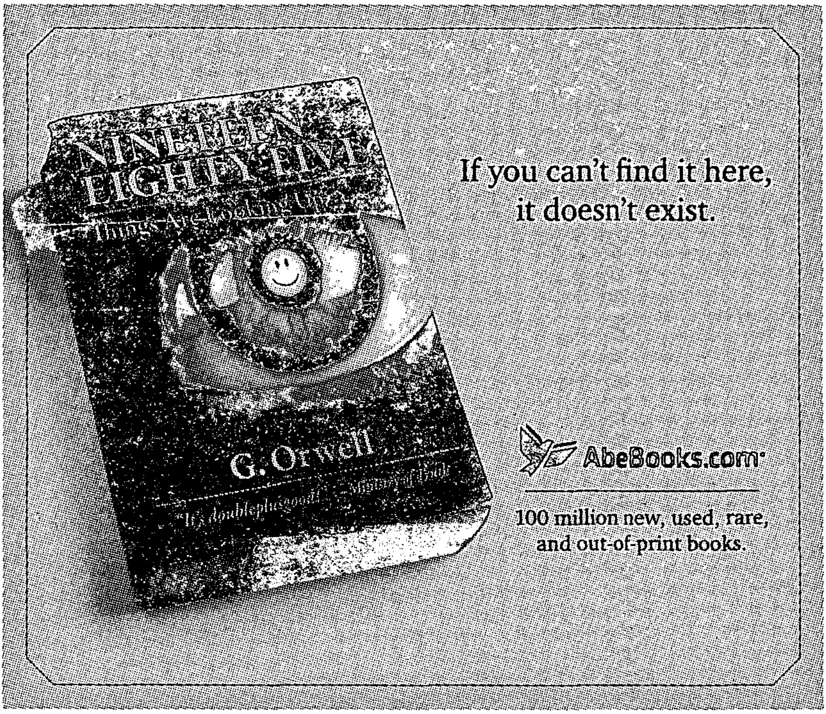
So I think we should figure, at least for a first approximation, that a dream recorder needs to be able to capture a pretty high-quality, full-color image. Since dreams include motion, it needs to be able to do this many times a second. How many, I'm not sure; commercial movies run at about 30 frames per second, but subjective time rate in dreams is not always the same as that recorded on the clock beside the bed.

If we accept that a dream should give a convincing illusion of reality, the images must also be three-dimensional. (Again, I know mine are, but I have no idea how representative they are of those experienced by others.) And some data will be needed to represent other kinds of sensory input, since a dreamer can also hear, smell, taste, and feel things.

And then there's the question of what sort of format will be used to store all this data. For recording, it will have to be extracted in a form shaped by how the brain stores information, and for playback it will need to be put back into a compatible form. Computers typically store data as a pattern of bits in a specific location on some device such as a hard drive, but there is evidence that brains do something quite different, storing a memory not in a single location (so that if that part of the brain is damaged the memory is lost completely and permanently) but in a distributed way qualitatively similar to that in a hologram. In a hologram, information about all parts of a picture is stored in all parts of a film or plate, which has the desirable effect that even if part of the film is destroyed, a complete (albeit not quite as good) picture can still be reconstructed from what's left. A cranial counterpart of that would clearly have big evolutionary advantages, but as far as I know, nobody has yet figured out exactly how it works. If and when somebody does, they may find that it means recording thoughts or dreams requires more

Analog Science Fiction and Fact (Astounding), Vol. CXXVII, No. 7 & 8, July/August 2007. ISSN 1059-2113, USPS 488-910, GST# 123054108. Published monthly except for combined January/February and July/August double issues by Dell Magazines, a division of Crosstown Publications. One-year subscription for $43.90 in the U.S.A. and possessions, in all other countries, $53.90 (GST included in Canada) payable in advance in U.S. funds. First copy of new subscription will be mailed within eight weeks of receipt of order. When reporting change of address allow 6 to 8 weeks and give new address as well as the old address as it appears on the last label. Periodical postage paid at Norwalk, CT and additional mailing offices. Canadian postage paid at Montreal, Quebec. Canada Post International *Publications Mail.* *© 2007 by Dell Magazines, a division of Crosstown Publications, all rights reserved. Dell is a trademark registered in* the U.S. Patent Office. Protection secured under the Universal Copyright Convention. Reproduction or use of editorial or pictorial content in any manner without express permission is prohibited. All stories in this magazine are fiction. No actual persons are designated by name or character. Any similarity is coincidental. All submissions must be accompanied by stamped self-addressed envelope, the publisher assumes no responsibility for unsolicited manuscripts or artwork.

POSTMASTER: Send change of address to: ANALOG SCIENCE FICTION AND FACT
6 Prowitt Street, Norwalk, CT 06855.
IN CANADA RETURN TO: Quebecor St. Jean, 800 Blvd. Industrial, St. Jean, Quebec J3B 8G4
Executive Office: Penny Press, 6 Prowitt St., Norwalk, CT 06855
Editorial and Advertising: Analog Science Fiction and Fact, 475 Park Avenue South, New York, N.Y. 10016
Subscriptions: Analog Science Fiction and Fact, 6 Prowitt Street, Norwalk, CT 06855.
Printed in Canada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storage space than a computer engineer might expect. (Or less: maybe the information is stored redundantly, but a single input can get it into the system for processing.)

Nonetheless, the data requirements for conventional hardware storage of three-dimensional moving images with

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sound (plus other senses) will probably give at least a fair first approximation of what a dream recorder might need to be able to do. And those would appear to be quite large.

On the other hand, they may not be as large as they first seem. Is it really necessary to record minute detail in all parts of the image? Maybe not; after all, in waking reality we're seldom, if ever, conscious of anywhere as much detail as our surroundings contain. For example, even if we have eidetic memory and store a mental "videotape" of all the scenery we pass in driving from New York to Dubuque, I strongly suspect the images will be much more detailed in regions we were paying particular attention to (like an unusual billboard that interests us) than those that we weren't (red barns may register only as a vague impression of red barns, with no detail about the arrangement of doors, windows, and trim). Also, much of what we see goes into short-term memory only and soon dissipates (like dreams) without ever being transferred to long-term "archives"; but that's irrelevant to the question of dream recording since there we're concerned with simulating real-time experience.

So it would seem that a dream recorder could get away with storing a lot less information than a fully detailed picture of everything in its setting. It only needs enough to store detail about the parts of a scene the dreamer is paying attention to, and only a vague, generalized suggestion (dare I compare it to a French Impressionist painting?) of the rest.

Or does it?

That analysis may be valid if the dream recorder in playback mode works by forcing the user's mind to mimic exactly the mental activity of the dreamer—but that would seem to require suppressing any independent thought by the "redreamer." I suspect that's difficult to achieve, and would likely be so unpleasant that no one would want to experience it voluntarily (though some people might have nefarious reasons for wanting to do it to someone else). I suspect most users of a dream player would like the experience to be more like "virtual reality," wherein they can choose for themselves what parts of the scene to concentrate on—even parts that the original dreamer didn't.

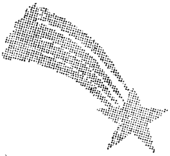
But the ability to do that gets us back to requiring lots of memory, so that there's adequate detail to provide verisimilitude wherever in the played-back dream the user chooses to look.

However, I anticipate one more catch. Even if you have enough memory storage in your equipment to capture a fully detailed dream sequence, can you even get one to record? My suspicion is that you can't—because the original dreamer is likely only generating much detail in the "central" parts of the scene. So no *matter* how much detail the *machinery could* record, the user trying to look elsewhere in a played-back recording may find there's nothing there except vague suggestions of shapes. And that would be rough on the whole illusion of reality, because in reality you can always shift your attention to look closely at new things. In dreams, that may be intrinsically impossible, and the moment you look away from the original dreamer's focus, the illusion goes away.

So . . . I'd still like the chance to play with a dream recorder, but it may be a very hard thing to build—and even the best possible may be less than I'd hope. ■

> Everybody gets so much information all day long that they lose their common sense.
>
> —Gertrude Stein

Jayge Carr
1940-2006



Margery Krueger, better known to science fiction and fantasy readers as Jayge Carr, died of cancer on December 20, 2006. Born (July 28, 1940) and raised in Houston, Texas, she spent her last years back in Texas after living in several other states. Despite such indignities as being denied membership in her high school's rocketry club because she was a girl, she studied physics at Carnegie Institute of Technology and Wayne State University, earning one degree there and being well on her way to a doctorate at Case Western Reserve University when she left to raise a family—and write.

Her first published story was "Alienation," in the October 1976 *Analog*, and her subsequent output included three novels (*Leviathan's Deep*, *Navigator's Sindrome*, and *The Treasure in the Heart of the Maze*) and a wide range of short stories and novelettes, many of them in this magazine. Though recurring themes in her stories included such weighty matters as bigotry and pollution, there was also a perennial element of fun in them. In her own words, "Writing is fun…and…I can always hope, that if it's fun to write, it's also fun to read." Critics sometimes regard her as a feminist writer, but she preferred to think of herself as a "peoplist," adding, "Everyone should have equal opportunities and no one should be shoehorned into a role unfitting or barred from a role desired because of sex—or age, creed, color, or what-have-you."

She is survived by her husband, Roger; daughters Cynthia and Sharon; sisters Carol, Joan, and Patsy; and granddaughters Carina and Alanna, to all of whom we extend our sincerest condolences.

—Stanley Schmidt

Quaestiones Super Caelo Et Mundo

Michael F. Flynn

Illustrated by Willliam Warren

When big events
happen can depen
on little things. . . .

What happened before.

If you stand on the mountain peak of any great age and gaze toward the past, you may spy in the purpled west the jagged range of another great age. And make no mistake: those distant peaks mark as great an age as any, and there were giants on the earth, men whose names ought never be forgotten:

Peter Abelard and Bernard of Clairvaux; Blanche of Castile and Good King Louis; Hildegarde of Bingen, "the Sybil of the Rhine." Robert of Chester, Adelard of Bath, Peter of Cluny. They are all "of" somewhere, but they go everywhere. Abelard has returned to teaching and at his aged feet sit Arnold of Brescia and John of Salisbury. Young Eleanor of Aquitaine is the Queen of France and patroness of the troubadours. Oh, those were names to conjure with!

Something is happening. Something is in the very air. Adelard of Bath has inhaled the *Elements of Euclid* in Arabic and exhaled them in Latin. Robert of Chester has translated the *Al jabr of al-Khwarizmi*—and Peter of Cluny desires he do the *Qur'an* while he's at it. And what about this Aristotle person?

In the center of the maelstrom: Toledo, glorious Toledo. They are all there, or they come there—eager, bustling, busy—to Archbishop Raymundo and his translation school. Gundisalvo is there. Robert of Chester has come, and Hermann of Carinthia. John of Seville and Plato of Tivoli. The names alone tell the tale: Spaniard, Englishman, German, Frenchman, Italian, all of Europe has gone mad for reading. They rub shoulders with al-Battani and ibn Sina, with Jacob ben Mahir and Moses ibn Tibbon. There has been nothing like it in all the world since the storied House of Wisdom in old Baghdad, before what once there flowered died.

These are no stolid peasants, gawping at wonders collected by their betters. They've been schooled for generations by the encyclopediasts of decaying Rome, by Macrobius and Pliny, by the Old Logic of Boethius. They know their Plato, and those tantalizing fragments of Aristotle that had drifted West before the old imperium fell. Thin soup, maybe, *but they have a taste for soup!*

Gerard of Cremona has dipped his pen, and when *he* is done, Europe will be drunk with Pierian spring-water. He has come to Toledo in search of Ptolemy's *Almagest*, and there, as his students would one day write of him, "*seeing the abundance of books in Arabic on every subject, and regretting the poverty of the Latins in these things, he learned the Arabic language, in order to translate. To the end of his life, he continued to transmit to the Latin world, as if to his own beloved heir, whatever books he thought finest, in many subjects, as accurately and as plainly as he could.*"

No finer epitaph was ever written.

He was the education of Europe. Ptolemy's *Almagest*. The *Physics* of Aristotle and his *Meteorology*, *On the Heavens and the Earth*, *On Generation and Corruption*, the *Posterior Analytics*, Euclid's *Elements*, *The Geometry of the Three Brothers*, Galen's *Medical Art*, ibn Sina's *Canon of Medicine*, al-Razi's *Book of Divisions*. A dozen astronomical texts, seventeen on mathematics and optics, fourteen on logic and natural philosophy, twenty-four on medicine. *Did that man never sleep?*

Hardly ever; but the sun does grow long and a man's eyes are not what they once were. Reading glasses are a hundred years yet to come, and the toll is telling in squints and headaches, and one day Gerard rubs the bridge of his nose and considers his bed.

The candle gutters. The sun has touched the rim of the Toledo hills. Hermann has gone, and John. He is alone in the scriptorium. Books whisper from pigeonholes racked upon the walls. The toll of the Angelus drifts through the windows with the breeze. Gerard reaches out, fingers poised to pinch the candle flames.

But, no. Perhaps one more, something to read before sleep. He scans the shadow-gathered room, spies a dusty bin in an ill-lit corner. He goes to it and finds there a folio written on brittle papyrus. But the writing is Greek, not Arabic, and he sighs because Greek is not his strength. He closes the cover, almost puts it back. Yet . . . Greek can be translated using *verbum de verbo*, its word order being much like Latin. So, why not?

He carries the volume back to his desk. On such whims, turn worlds.

His lips move as he reads the title. *Commentary on the Physics of Aristotle*, by John Philoponus, and he laughs. John "the Work-lover"? He thinks he might have enjoyed this man's company.

Gerard has already teased the text of the *Physics* from amidst ibn Rushd's Arabic commentary, but copyist errors multiply like loaves and fishes, and the Arabic had come from the Syriac, which had come from the Greek. How many stumbles of the pen on *that* journey? Now here is a Greek commentary on the same text. He can check the Philoponus against the ibn Rushd and thereby synthesize a more accurate version of the Aristotle. He reads further and sees that Philoponus has dedicated his work to . . .

Justinian, emperor of the Romans.

A cold hand seizes Gerard's belly when he reads that. Age wafts from the text as the breeze off an Alpine glacier. The Goths had ruled Italy when these words were written. The Hagia Sophia was new, and Mohammed not yet born. Yet, Aristotle was as distant to Philoponus as Philoponus is to him. Gerard feels suddenly the gaping depth of time; and hears the echo of a long, slow dialogue whispered across the ages.

He impales a fresh candle on the sconce and begins to read. This first pass will be to grasp the gist of the book (and he will note difficult passages as he reads) but it is also for pleasure. A few chapters, then to bed.

But the candle stub finds him hunched over his copy desk, brow furrowed, a knuckle caught in his teeth. Philoponus' *thesis* is clear.

Aristotle is full of crap.

Gerard suddenly imagines a new volume. A *disputatio*. He will couple this work with Aristotle's recovered text into a gigantic sort of *Sic et non*. Let the two old Greeks wrestle between the covers—and the Latins would judge the winner. He scrapes a sheet of palimpsest clean with his razor, dips his quill into the ink, and joins the dialogue.

The sun is up and dozens of candles have lived and died and still Gerard writes, stopping now and then only for quick meals or fitful naps. By summer's fevered end, he will have finished and the manuscript will go to the copyists.

Afterward, matters great and small progress pretty much as before.

But, not quite.

What happened after.

Two hundred years have fled and Gerard is dust forgotten. The New Age is seized with enthusiasm for power. Water has been tamed, and the wind harnessed; and some dream of controlling the very gravity of the earth. Camshafts and overhead springs and newfangled cranks. Clocks have begun to toll the hours in the public squares of Europe. A new word has appeared: *ingeniator*—the engineer—and for the first time in history, a civilization does not cinch its saddle upon the sweating backs of slaves.

It is Paris, it is the center of the world, and Jean Buridan de Bethune makes his way through the raucous stalls in the cathedral market place. Fishmongers cry, greengrocers hawk their produce, butchers whack great carcasses hung from hooks. A jongleur sings over his lute while his apprentice taps a small tambour. Pilgrims throng the square, pointing and chattering. The tower bell above the Church of Our Lady of Paris announces *tierce,* and Buridan, peering past the scaffolding that still adorns the cathedral's upper reaches, gauges the sun's position. He plunks some copper pennies on the bench and departs the poulterer's stall one goose the wealthier.

Buridan himself is goose-plump, but he is a chimera: his nose evokes a horse, his lips a frog. He is an important man, Rector of the University of Paris—a great, sprawling guild of masters brooding like doves on that very left bank of the Seine where Abelard once taught. He has mastered every science known to man. He can recite the *Physics* of Aristotle—and explain where the Stagerite went wrong. Students flock to him with their fees, so that he has become that singular anomaly: a scholar with a full purse. He is the sort to whom legends cling like filings to a lodestone. Some say he once struck the Pope on the head with a shoe in a quarrel over a woman. Perhaps the story is even true; Buridan never denies it. The two had been students together at this very university; but he is past forty now, and gray flecks his temples. He no longer fights over women and counts himself fortunate even to find his shoe.

At the Grand Bridge, he encounters Marcel Etienne, the clothier. A young man with smoldering eyes, suddenly heir to his grandfather's commercial empire, Etienne aspires to the office of Provost of the Grand Fraternity of Our Lady, and spends his time "beating the kettledrum" for votes among the merchants that sell there. Buridan finds himself trapped by the geometry of bridges.

"Bad news from Flanders, Rector," the merchant declares in lieu of greeting. "Van Artevelt and the cloth makers have risen up and the price of your new cloak will rise up with them."

Buridan lifts the goose's head from its leather bag. "Do you hear, my old? Master Etienne demands more for my cloak because some weavers in Flanders have gone out."

The goose remains noncommittal; the clothier does not. What do Arts Masters know of money and trade! Etienne waves a hand, encompassing all of commerce and politics. "For three years now," he explains, "Edward has cut them off from the English wool, which as all men know is the best wool to be had. Now the weavers have gone to the streets to declare him the rightful king of France." Etienne wags a finger with the assurance of youth. "Mark me, Master Buridan. This will be Edward's *casus belli*. Soon, English ships appear off Sluis and seize Flanders. What then, the price of your cloak?"

There is more. Etienne's verbal *carnivale* runs from the "Matins of Bruges," through the Battle of the Golden Spurs, to the white heron served to the king. He recounts how, following the Revolution, the Flemings had traded exigent guild masters for Count Guy, then Count Guy for King Philip. Now, languishing under the oppressions and taxes of the French crown, they seek the English to rid them of the French.

Buridan thinks the Flemings slow learners. He pleads another appointment and escapes Etienne's lecture. Everyone, it seems, would be king of France: Valois, Navarre, Burgundy, now Plantagenet. He thinks that if there is a war, Valois will call on his vassal, the Duke of Aquitaine, to fight his enemy, the King of England, and he laughs because Edward Plantagenet holds both titles.

The waters of the Seine are choked with floating mills—sixty-eight between Bar Street and the eastern tip of the Isle of Our Lady—and Buridan pauses at the parapet of the Grand Bridge to watch the wheels splash and turn and the water sparkle in the sun. The prospect is at once restful and invigorating. The mills are moored under the arches, where the current is stronger. Thirteen churn under the Grand Bridge alone. Beneath his feet mill stones rumble, saws rasp, fulling hammers thud.

A stocky man in a dusty cloak brushes past him with two apprentices in his wake. The apprentices carry a large wooden cam slung on a pole across their shoulders. They clamber down the broad stone stairs that lead from the bridge to the riverside, where a miller steps forth from one of the floating mills to welcome them. Consumed by a sudden curiosity, Buridan follows.

Nor is he alone. The ingeniator has attracted a small crowd, as men find ever in the labor of others a reason to desist from their own. However, the miller expels all bystanders from the mill, save only "my sir, the Rector" and a man and woman of bourgeois mien. These two, as polite introductions reveal, are members of the *Anonymous Civil Society of the Mills of the Seine*, and between them they hold seven of the eight "shares" of this particular mill. The miller himself is but their hireling.

That worthy stands by, bouncing a little on the balls of his feet. "What we really need is an overshot," he tells Buridan, as if in confidence. "An overshot wheel delivers more of the power of the current, but tell the Town Council that! It would not close the channel of the navigation, no, my sir. It wants a small dam only, but—" But the ingeniator calls on him to stop the grindstone, if he would please, so that work might proceed on his by-Our-Lady improvements. So the miller and his apprentice heave on a mighty wooden lever to disengage the crown gear. Gears shift, disengage—and the grindstone continues to roll for a time before coming to a stop.

Buridan has often seen such posterior motion—or *momentum*, to use the Latin. Aristotle thought it a great mystery how a thing might move after parting contact with the mover; but modern science has found the answer in the *impetus*. Yet he considers that *circular* motion is not natural to the sublunar region, belonging rather to the celestial realm, where the planetary stars . . .

"Holy Blue!" he cries. "And yet they still move!"

All of them—ingeniator, miller, apprentice, shareholders—stare in amazement as Rector and goose fly from the mill to his lodgings on the Left Bank.

At *sept*, Albrecht of Saxony finds Buridan in his quarters, scribbling fiercely. He does not interrupt his teacher, but proceeds to the fireplace, where the wood is green and not burning well. He finds a bellows to blast the fire, but it is flat and, pull as he might on the handles, he cannot extend it. Albrecht is a young man of twenty, a most promising student, with fine features and hair like tow. His fingers taper delicately and his nose is long and thin.

Albrecht throws the instrument down. "There is something wrong with your bellows," he tells Buridan, but the master continues to scribble, pausing only to wave the quill over his head to show that he has heard. Albrecht shrugs, finds a sufflator, and takes it outside and down the stairs to fill it with water. The sufflator is cast of brass in the form of a human head with its lips pursed and cheeks blown out, like the boreal figures that represent the winds. By the rain barrel, he checks that the mouth-plug still dangles from the end of its chain. "You, at least, will answer," he tells the head.

"In his own good time," says Nicole Oresme, who has just arrived and has paused before climbing the stairs to Buridan's quarters, "much like our Master." Nicole is the complement to the Saxon. *A Norman blockhead*, he sometimes calls himself—unfairly, because his head is more sphere than block, the perfection of its curves spoilt only by the undershot chin. "Why did you fetch only the one head? Two heads are better than one. Wait, I'll get the other."

Albrecht watches him scamper up the stairs two at a time. Nicole is obnoxiously precocious. At fourteen, he has only this year achieved adulthood, yet he shines already a star in the academic heavens. Worse, he knows it.

The Saxon turns to the rain barrel and puts the funnel between the sufflator's pursed lips.

"You know what that looks like, don't you?" Nicole is on the landing above him, a second sufflator in his hand.

Albrecht does not look up. "I think you've told me once or twice."

"Like it's performing fellatio."

"Or thrice. Don't you plan to become a priest or something?"

"Not yet. Has the Englishman come?"

Albrecht jams the stopper into the sufflator's mouth, giving it an extra rap to make sure it is tight. "Not yet. The Mastah went himself this morning out, and fo' the dinnah bought a goose. Cook has it now." Being a Saxon, Albrecht sometimes drops his final *-er* and twists his long *o*'s and *u*'s into peculiar diphthongs. This gives his Latin a whimsical inflection, whence the passive voice of his verbs masquerades oft as the dative of their participles.

Oresme makes a show of sniffing the air. "Will it be ready in time? Will one goose feed four?"

"If not, you may fast as a penance for your vulgarity."

In answer, Nicole puffs his cheeks out and blows hard on the finger he has stuck in his mouth. Albrecht cries, "Catch!" And he throws the sufflator, now full of water, like a Scotsman hurling a stone, taking the younger man off his guard.

Nicole is near-sighted. He fumbles for the head one-handedly and in so doing loses his grip on the other, and both sufflators seek their natural place, landing at the Saxon's feet.

The young Norman scampers down the stairs. "Look what you made me do!" he complains. "If you've busted the master's brass balls . . ."

But both are whole. A relief! Albrecht fills them and, this time places the one in Nicole's arms as gently as a nurse returning a mother's newborn. The other, he carries himself. On his way up the stairs, he glances down at the place where the brass heads had struck, and purses his own lips in unconscious imitation.

If the world does turn on itself with a diurnal motion, as Buridan and others suspect it may, it makes precious little noise in doing so. The hinges of the world must be well greased, for it turns over always in quiet moments. It turned over once when Gerard of Cremona picked up his pen. It turns over again when Jean Buridan de Bethune puts his down; and maybe there is just the slightest creak when he does. If there has ever been such a creak, it is then, it is there, in that room.

Possem enit dici, he has written, *quod quando deus creavit sphaeras coelestes, ipse incepit movere unamquamque earum sicut voluit; et tunc ab impetus quam dedit eis, moventur adhuc, quia ille impetus non corrumpitur nec diminuitur, cum non habent resistentiam.*

Or to put the matter more plainly: A body set in motion will continue in that motion if it meets no resistance.

There. In a few strokes of the pen he has disenchanted the heavens. There is no need to suppose the celestial spheres filled with Aristotle's "fifth element," the *quint essence*, whose natural motion is circular. No need to distinguish celestial from sublunar physics. Since God created the heavens *and* the earth, the same forms that account for earthly motions may also account for those of the heavens. Uniform motion above, where there is no resistance, difform motion below, where there is.

"After leaving the arm of the thrower," he tells his students, "the projectile is moved by an impetus proportional to the body's weight and speed. The body will continue to be moved so long as this impetus remains stronger than the resistance, and, *the impetus being permanent*, motion will be of infinite duration if it be not corrupted nor diminished by a contrary force resisting it, or by one inclining it to a contrary motion."

Nicole bounces with excitement. "Then you don't need the Stagerite's Intelligences to keep the spheres turning!"

Buridan shrugs eloquently. Aristotle is full of crap, his shoulders say. If the Stagerite was wrong on matters of theology, as a Bishop of Paris once decreed, then might he not also be wrong on matters of the physics? "As my own master was fond of saying," he tells his students, "we ought not call upon entities we do not need. One might *assume* that there are many more separate substances than there are even celestial spheres and celestial motions, and invoke whole legions of angels to move them . . ." He waves his arms grandly at this. ". . . but this cannot be demonstrated by arguments originating from the senses, and the philosophy of nature demands always that our arguments be sensible."

Albrecht glances toward the stairway with a contemplative look and his lips part, as if to speak, but the young Norman pipes up. "The world is a gigantic clock that God set in motion at the Creation and runs now by itself!"

"The *machina mundi*," Buridan repeats the common phrase, "runs by the laws of nature set by nature's God."

Albrecht smiles. "A clockwork world? Ach, that has right. The Lord has better things to do than spinning planetary spheres. Saving Nickl's soul wants his full attention."

Oresme tries to knock Albrecht's cap off, but is defeated by the Saxon's height. He settles for making a fig with his left hand. "But master," the young man says, "according to the Stagerite, velocity is the ratio of the motive force to the resisting force. So without resistance, speed must be instantaneous, and a body would be in two places in the same instant, which is impossible."

"Which alone tells us that Aristotle was mistaken," Buridan comments. "Albrecht, would you explain for our bachelor?"

"*Internal* resistance, yngling," the Saxon replies with a swat, easily ducked, toward the Norman's head. "All material bodies are composed of elements in various proportions; so that in part they fall and in other parts, rise. Thus, a falling body will from its own airy or fiery parts resistance encountah, even in . . ." His voice trails off at the end. ". . . a void."

"Should a void exist," Buridan adds the usual disclaimer. "This 'intrinsic resistance' makes it difficult to start a heavy body into violent motion." He waves his hand. "The external resistance from the air, pfft! For a heavy body, it is nothing. No, lad, a body resting wants to remain so, by an inner nature which we call 'inertia.' Or 'ideleness.'"

"Like Albert? It's hard to get 'Farmboy' moving, too!"

Buridan smiles. "Albertus!" he says, because the lean Saxon has not responded to the jape. "You are not listening! What engages that subtle mind of yours?"

The Saxon suspects gentle mockery, for the Franks do love to chatter, and thus confuse Germanic silence with having naught to say. "When Nickl the two heads dropped . . ." he stammers, falling into the rhythms of his milk-tongue. But what notion the plummeting sufflators has suggested goes once more unsaid when Nicole waves the bellows.

"Shit! Someone's plugged the damned thing!"

Buridan snatches it from him before he can remove the plug. "A small gift for Heytesbury when he comes."

"A plugged bellows? Oh, the Picard humor, she is more subtle than even the Saxon."

"Mock not the *Ch'ti*!" Buridan says gravely. "This jape," he says aside to Albrecht, "from a man who drinks from a 'mug' instead of a 'tasse,' and whose land boasts 'castels' rather than 'kateaus.'"

Albrecht scratches his head. "Don't the French say, '*ch*ateau'?"

Buridan waves dismissal. "The French speak with porridge in their mouths. When I eat with the French Nation, the servants affect not to understand Picard."

The Saxon shrugs. "Norman, Picard, French . . . It is to me all the same."

"Well said!" booms a new voice from the doorway, and they turn, and there framed they spy a tall man, all bones and angles, with a nose like a halberd and long, wild hair that suggests motion even while standing still. "Yet they lump your savage folk with mine," he cries, "into a single nation!"

Buridan grins. "Anglo, Saxon, it all sounds the same to me. That's why civilized men use Latin." He rises from his stool and welcomes his guest. "William, how delightful!" The newcomer's youth surprises him—he is but three-and-twenty. Yet he is, after all, a Fellow of Merton College; and while Oxford is not Paris—what town is?—she produces scholars of no mean merit.

The Englishman returns the embrace, though not the kisses on the cheek. "Greetings," he says, "from 'the Calculators of Merton.' And are these your two prizes? Not very likely specimens, what?" He exchanges a hearty grip with Albrecht and claps young Nicole on the shoulder.

Buridan shrugs. "One manages. I thought we would eat here in my quarters, rather than in the Nations. After all," he indicates the four of them, "in which would we dine, Norman, Picard, or Anglo-German?"

"Your 'Nations' are like our 'Colleges,' what? Endowments that provide scholars with room and board? Yes, I rather thought so; though ours are not based on the language the scholars speak. Still, I suppose that if students must board together, they ought to be able to talk together at table. Where shall I be quartered? Here? Excellent! Excellent! Just a moment." And the whirlwind spins and shouts, "Oswy! Oswy!"

The short, burly servant is standing right behind him with a coffer on his shoulder and resignation on his face. "Oswy!" William tells him, "We are to have the room two doors on the right. This side, the *right*. Yes. Two doors."

Oswy turns just as the kitchen maid enters with the goose on a great tray. There is a confusion of coffer and goose, and an evolution much like an *estampe*; then the wench is dancing into the room, the platter precarious, the goose in deadly peril!

Saved by the Norman! A steady hand to the platter, a steadier one to the waist, and all that is lost is a little grease splashed upon the hearthstones, and a few years in Purgatory for the thoughts that rush through the young man's mind. A whisper, a giggle, a nod, then she is at work at the hearth, casting sheep-eyes at Nicole while she impales the goose on the roasting spit. After engaging the spit's chain to the blades, she wrestles the two sufflators to the fire's edge. "This'll do ye up fine, m'sir Rector," she says. "Cook says she's done, but ye should let 'er roast a bit 'till the skin gets crispy-like afore ye eat 'er."

"Very good, Lizette. You may set the table . . ." Buridan looks around the room, and each table is encumbered with books. ". . . that one. Boys, put the books in their cases, so they don't get soiled. Here, William, this is for you." And he hands his guest the bellows.

Wench, grease, spit, table . . . bellows? The Englishman turns his attention to the device now pressed into his hand. He hesitates, pulls tentatively on the handles, scowls a bit, discovers the plugged nozzle, and falls into a study. Finally, he bursts into laughter. "Nature abhors a vacuum!" he cries.

Stacking the books at the table, Albrecht and Nicole glance at each other, then at the Englishman. "All right . . ." says the Saxon.

"The principle of first and last moments," Heytesbury exclaims. "Surely, your master has . . . He hasn't! Why, what a sorry deficiency!" He waves his hands as he talks, a human windmill. He may fly off like a bird at any moment! "'Sooth, it is simplicity itself, and illuminates natural philosophy with mathematics."

"'*Sooth*?" says Nicole.

"The Merton Calculators," Buridan comments aside to his students, "believe that ratios and geometries can reveal the secrets of nature."

"While the Parisians place their faith in reason," the Englishman parries offhandedly. "Bradwardine says that anyone who studies the *Physics* without mastering mathematics will 'never enter the portals of knowledge.' The plug will not allow the air to rush in to fill the vacuum, so nature prevents the two plates of the bellows from separating. To see why this is so, consider the separation of two parallel plates in general. Remember, God may do anything short of a logical contradiction, so He may permit a vacuum if He so chooses. But has He ever done so *in fact*?"

He spreads his hands, as if in appeal, to the two students, who remain mute.

"Come now," the Englishman insists. "If two plates are in perfect mathematical contact, with no material between them, and they are separated in such a fashion as to remain parallel, it would seem that a momentary vacuum must be produced. Why?" He stabs a finger at the Norman.

Oresme sees no escape. He twists his hand palm up, as if to say it is obvious. "Because at the moment of the separation the air will rush in from the perimeter, but some brief time must elapse before it reaches the center."

"Excellent! Yet, how can this be?" Heytesbury continues, "Consider first the two plates approaching." His hands are plates. They approach. "The air between them becomes progressively more rarefied; yet at no time does the air actually part to form a vacuum in the center because there is no *last moment* at which rarefaction ceases prior to the contact of the plates. Thus, there is no last instant in which the plates are separated. But there *is* a first instant in which they are in contact. Rarefaction *approaches* a vacuum, but never attains it because the limiting form—actual contact—is *extrinsic* to the intension of the rarefaction itself."

Albrecht nods. "And separation likewise? There is no first instant of separation?"

Nicole pokes him. "Of course not, Farm-boy. Suppose there *is* a first moment of separation. But, if they are separated, there must be a small distance between them—"

"And so," the Saxon' voice overrides him, "however small, a smaller distance must have preceded it. Thus, we haff a last moment of contact—an *intrinsic* limit to contact, doch?—but no first moment of separation." He shakes his head slowly, grappling with the idea of open and closed sets.

Heytesbury waves his hand dismissively while he paces about the room. "We Mertonians have not determined all the questions the continuum raises, but we do know that Aristotle was wrong about forms. They are not 'either/or.' They are 'more or less.' A form like rarefaction can be intensified or diminished. If we could but measure that . . ." This last he says wistfully, gazing upward, as if entreating God for an instrument, any instrument, that could measure density or heat or color or charity.

Dropping his eyes, he notices that the goose turns on the spit with no hand moving it. A problem of impetus! Another of Buridan's pranks? He studies the spit from various angles; spies a chain wrapped around a toothed wheel; crouches and looks up the flue.

"Attend!" the Rector cries. "Your hair!"

But the ends are singed only a little. "There is a wheel with blades in the chimney," the Englishman says as he straightens, snuffing the sparks in his hair, "and the hot air rising to its natural place turns the wheel, which turns the spit."

Buridan nods. "But yes! We call it a *turbinus*, after the spinning top the Romans used as a toy. They are become quite popular of late. It is mere engineering; yet it illustrates the matters philosophical. It is in principle as the water wheel, no? But instead of the water rushing down, it is the air, as is proper, rushing up."

"Exquisite! Both air and water take on the nature of a fluid, what? Oh!" He takes a sharp turn into another topic. "The monks at St. Albans—you know the 'Instrument Makers'? Abbot Richard has only just died, it grieves me to say—but he crafted a most exquisite instrument . . . You know how the ingeniators are trying to build a portable clock? A peripatetic timepiece for the Aristotelians, hah! 'Sooth, 'tis not enough to erect one in every town square; now there must be one in every house. Soon, they will dangle on lanyards from our very necks, hah-hah! But the ingeniators *envision* that which they wish to achieve, then they essay divers arrangements of gears and balances to find their way to this vision. I hear they are trying springs; but springs lose potency as they unwind and they've not yet come up with a device to compensate for that. So Abbot Richard, knowing how young men like your Nicole, cannot see far off but only close at hand, envisioned a lens—"

At this juncture, the first sufflator blows. The fire, transferring its quality of heat to the water, has brought the latter to a boil. The stopper pops out of the figure's pursed lips, and the head of steam vents into the hearth with a long, high whistle. Steam is air and water, and water is contrary to fire; but the element of air dominates and so blasts the fire into more lively flames.

"It does sound like whispering," Heytesbury observes in an aside. "Pope Sylvester had one of these in the old days, and simple folk thought that the head whispered secrets to him. Look how fast your turbine spins with the jet upon it! Hah! Delightful!"

The second head of steam sits upon the pool of grease that had earlier been spilled by the serving wench. When it erupts, the head slides backward through the grease, away from the fire until it reaches drier wood and resistance halts it.

"Holy Blue!" cries Buridan in amazement. Heytesbury cups his chin, laying a finger by his nose, and stares at the sufflator, whose jet now spews steam uselessly into the room. The two students look at each other.

"It moved," Nicole tells the senior.

"So there must have been a mover," Albrecht agrees. "The steam?"

"No, the steam went *that* way, but the head slid *this* way." A new species of motion? But motion is not an entity, only a term used to describe a body's successive acquisition of the form of location. But what had just pushed it? The steam is implicated in some manner. As more and more heat is placed into the water, the intensity of the heat—or "temperature"—increases because the volume of the water remains the same. So it is clear why the excess heat seeks to escape in violent motion. Yet, *why should the sufflator take on a contrary motion?*

Miracles are, of course, possible; but Aquinas had warned that an action may seem miraculous only because its form is occult, which is to say, "hidden." Yet what is occult to one man may be manifest to another, or to the same man at a different time. Nicole considers how he might become that man. He ought first establish, by repeating the experience, that a common course of nature obtains, for no certain knowledge may be had of chance events. The others bustle about him almost unperceived while he ponders the question.

Dinner passes less dramatically and the only "talking heads" are those of which one normally expects vapors. Servants take their accustomed places behind the chairs, to fetch fowl or ale as the diners' appetites move them. Heytesbury's man, of course, attends his master, but Buridan's kitchen wench jostles the other servants to stand behind Oresme. The young Norman grins at nothing in particular.

Heytesbury hints at a marvel he has brought with him, gesturing with his fork so wildly that, sitting beside him, Albrecht fears impalement. "The very one Abbot Richard fashioned." Heytesbury does not amplify, and Nicole suspects that he enjoys drawing out the suspense. It had best be a damned good marvel, he thinks.

"Abertus," Buridan comments over a leg of goose and black currant sauce, "you have been more absent-minded than usual this afternoon."

"Well . . ." Albrecht rubs his long, thin fingers down his chin. "I can see how homogenous mixed bodies must move at the same speed in a vacuum, regardless of their weights; but their motion in a plenum still puzzles me."

Oresme laughs. "That was clear, cabbage-head."

The Saxon turns on him like an act of nature. "One day, 'Lefty,' you will toss one jape too many. I may have grown up on a farm, but we farm-boys know something you city-folk do not."

"Really! And what is that?"

"We know shit when we see it."

Buridan and Heytesbury burst into laughter, and Nicole mutters a word that is no more Latin than "'sooth," but which is commonly heard in low places about Normandy.

Albrecht explains his reasoning to Buridan: "If a body is hömo—is homogeneous, every part of its material contains the same proportions of elements and so each portion of material must at the same speed fall. So, imagine such a body divided now into one-third part and two-thirds parts. Since each body possesses the same ratio of gravity to levity, *each* must fall at the same speed. In a blenum—in a *p*lenum—the external resistance would be greatah on the largah body, but . . ."

"But?" his master prompts him. Heytesbury, listening bright-eyed, grins to bursting with a secret. "Oswy!" he bellows. The servant standing behind him tugs his forelock. "Oswy, bring me my satchel! There's a good fellow."

"But I *saw* dhem fall," Albrecht says, his enthusiasm resurrecting his Saxon accent. "Nickl dropped böth sufflatahs, and you haff dtold us how seeing d' millstone caused you to reconsidah heavenly mötions, ond you haff always said dhat natural philosöphy begins vit d' senses, ond Albertus Magnus wröte dhat 'Experience is d' önly guide,' ond . . ."

Ond his Master and fellow student stare with amazement. They have never before heard so many words jostling and stumbling out of the Saxon's mouth at one time.

"*Ond*," Albrecht concludes, "I saw böth heads strike d' ground at d' same möment, even dö one was vit water and one vit air filled. But vatter falls ond air rises, so d' second head ought haff less guickly g'fallen." Oh, the mush-mouth drawl of the Saxon hills can baffle a Bavarian, let alone a Picard, a Norman, and an Englishman. It is difficult enough to follow his accent, let alone his reasoning.

"Perhaps it did," Buridan suggests when he has "buzzled öut" his student's idea. "It is a question of summing up the parts of each element. If the sums are of similar magnitude, even if one be slightly the greater, no sensible difference may result. Nicole, did you see it happen?"

But the Norman shakes his head. "I wasn't watching. It wasn't my fault they fell . . ."

Buridan waves a hand in dismissal. "Perhaps the difference in gravity was too slight to be sensible. What if you were to drop a sufflator and . . . the Moon!"

Heytesbury barks laughter. He had not looked for *that* example. His eyes dance, resting on the Saxon, eager for his response. He knows the game of *obligations*. As *interlocutor*, Buridan will try to trap his student into holding a contradiction. At this juncture, his man, Oswy returns and places a leather satchel in his hands, and this he lays on the table before him.

"What foolishness!" Albrecht cries in despair. "The Moon cannot fall!"

"But God could cause the Moon to fall if he desired," his Master insists, "so consider, *secundum imaginationem* . . ."

Heytesbury interrupts the "thought experiment" before it can progress further. "Albert, have you ever read Philoponus?"

The Saxon frowns. "No. His books are heretical. He said the Trinity was three different gods."

"He wrote other books," Heytesbury says quietly.

Buridan's eyes drop to the satchel with sudden interest. "He wrote a commentary on Aristotle," he says, "that refuted much of the *Physics*—and justly so, in my opinion. Gerard of Cremona was supposed to have translated him, but . . ."

"But who wants to read a heretic's book?" says Nicole.

Buridan turns to him. "The same who would read a pagan's book, or a Saracen's." He nods toward his own shelves, where Aristotle and Plato rub shoulders with Avicenna and Averröes. "A man may fall into error in his faith, and yet see nature clearly. Recall Augustine *On Christian doctrine*, or Aquinas, or Albertus Magnus." He returns to Heytesbury. "But Cremona's '*Philoponus*' has been lost. Abelard knew it in the old days, and thought ill of its 'base mechanic doctrines,' but the manuscript itself . . ."

". . . came into the hands of Brother Roger Bacon," Heytesbury tells him. "The 'Wonderful Doctor' was trained by Grosseteste himself, and also here in Paris by 'Pilgrim Pierre,' and so had a high regard for the evidence of the senses. I think he came by Abelard's copy when he was here. You've read the treatises Bacon wrote for the Pope, of course."

Buridan nods. He has not taken his eyes off the satchel. He knows what must be in there. It is all he can do to refrain from elbowing the Englishman aside and tearing the contents from its canvas wrapper. "I have always thought it a scandal," he said, "that your Order burdened him with so many other labors that he was unable to write more than he did."

Heytesbury waves a hand. "A general prohibition. An Italian brother had written theological treatises containing heretical ideas, so our General required all writings be reviewed by peers within the Order before being sent out. Brother Roger expressed himself carelessly in his theology, and had insulted many potential friends—he really could be quite the ass, the older brothers tell me. But, as it may, his copy of the 'Lost Cremona' has lain buried in our library these past thirty years since his death. Bradwardine has only just discovered it."

"And. . . ?" Buridan's voice is heavy with lust. He is a sailor in sight of port, and Heytesbury realizes that he can suspend the matter no further. He opens the satchel and removes two bundles. One is a ream of parchment, quarto, tied between two stiff boards, which he hands to the Paris Master. The other is a smaller bundle tied in a rag. This, he passes to Oresme. Albrecht grumbles. What, no gift for him?

"Do not fret, my Saxon giant," the Englishman assures him with a clap to the shoulder. "There is a passage in the Philoponus that will interest you greatly. You recall how Brother Roger wrote, 'Without experience nothing can be known sufficiently'?"

"As did Albertus Magnus," the Saxon replies, defending his namesake. "Remember how he always added to his statements, *Fui et vidi experiri*. 'I was there and saw it for myself.'"

Heytesbury brushes imaginary flies. "Yes, yes. And 'Pilgrim Pierre,' and Aquinas, and all the others said alike. But Brother Roger wrote of *degrees* of experience, and one, which he called the 'best experience,' is one in which all the forms affecting the experience have been accounted for by deliberate arrangement."

By deliberate arrangement? Albrecht purses his lips. "Would not artificial conditions affect the body's natural behavior? It is the *natural* behavior we wish to understand."

"Shit!" says Oresme, who is frowning over the pair of spectacles he has found in the bundle. "I'm no old man to need reading glasses."

Heytesbury turns to him, "Put them on! Put them on!" Then, without sensible pause, turns back to Albrecht and says, "Philoponus thought contrived experiences useful. So did Bacon, who wrote that we learn more through artful vexation of nature than we do through patient observation."

Albrecht glances at Nicole, who is gawking with wonder out the window of the apartment. "And what does Philoponus say about these 'best experiences'?" he asks.

"Yes, what does he say?" asks Buridan, who has been eagerly skimming the pages. He is already making plans to have a bookbinder set them between covers, and to have the university stationers produce several additional copies. His purse can afford the labor. Whether his patience can afford the wait is another matter. Yet the laborious process of copying a single book is one reason why so many become lost to mice and mildew and fire. If only there were some way in which a book could be written once, yet read many times.

Heytesbury is smug. "Why only that Philoponus, using a contrived experience, determined as your Saxon giant, that, against Aristotle, bodies fall at the same speed, regardless of their weight, and that their speed increases in . . ."

"In uniformly difform motion," says the Saxon. Then, to the startled looks he receives, adds, "It stands obvious, no?"

"I can see!" Nicole exclaims. But he does not mean that he understands Philoponus, or Heytesbury, or even Albrecht. He has discovered the world beyond his nose-tip. "There is a drover at the corner—" He stands at the window, pointing. "He holds a crook and drives one, three, eight pigs toward the pens. And that lady wears a kirtle in *orofrise* done up with scenes of hunting, and—Good day to you also, m'lady! And such superb melons!"

Now he has his master's attention. Buridan asks to see—the new spectacles; not the lady's melons—and Heytesbury explains how Abbot Richard had reasoned that if 'lentil-shaped' glasses help a man see close at hand, a concave shape must help him see farther away. "And there are the laws of *perspectiva*," he adds, "which Grosseteste used in *De iride*. Father Abbot drew diagrams of the paths of the rays, after Witelo's methods, as they enter and leave the faces of the lens. The most difficult task was the artisan's. Grinding a concave glass is not as simple as your convex reading lenses."

There is no help for it. Each must try Nicole's new spectacles, although none else can see more than a blur with them. Albrecht is nettled that Nicole has made himself once more the center of attention.

It is a rowdy era, as are all those eras when everything flips over. There are brawls high and low. Rhineland barons squabble. Kaiser Ludwig strong-arms Margaret Pocket-Mouth, the Ugly Duchess of Tyrol. The theologians of Paris have declared Pope John a heretic, again; and William of Ockham, safe at the Kaiser's court, wastes his pen on political screeds against him. The French fleet sails into Southampton and fires the town. In the Mediterranean, Genoa and Venice stumble through the final years of their long, drawn-out mutual suicide pact.

And in Paris, it is morning and a gang of young townies have spotted Nicole Oresme returning to Buridan's quarters in the University. Town has hated gown ever since the Pope freed the universities of local laws and exactions, and this bird is too easy a prey to pass up. Nicole might have seen them sooner, save that he is gawking everywhere in fascination of his new spectacles.

And what a spectacle he makes of it! Stopping, peering, laughing in delight. The laughter strikes the laborers as being at their expense. Another sneer from the haughty scholars at the common workman. Once again, the young Norman has made himself the center of attention, though he awakens only slowly to the honor.

Nicole finally notices the train of journeymen and apprentices he has acquired, sees their roughened, horny hands, hears their sniggering laughter. Perhaps there is no more harm in them than mere mockery, but the young scholar suddenly feels very small and very alone, and so he bolts suddenly toward the safety of the university.

It is the very worst thing he could have done. He is a flushed bird in flight! His gown flaps like wings. Even his cries for help sound remarkably avian. His pursuers are falcons launched.

Norman sandals slap cobblestones down narrow lanes. He overturns laundry baskets, thrusts aside screeching harpies. A stone hurtles past him—and he thinks, madly, of the prior day's discussion of bodies in motion. A second stone resets his academic priorities. Six-to-one is not fair odds, but he doubts his pursuers would care. He turns another corner . . .

. . . and Albrecht of Saxony is suddenly there, with his long, grave Saxon face and clumsy demeanor. This fails to dampen the townies' humor. Two scholars? It is still three-to-one!

Save that one is a farm boy and has grown up wrestling with calves and other livestock. He may be long and thin, but every thumb-length is tough as rope. Besides, he has a club—a billet snatched up from the construction site, and he knows its use. Rural Saxony has not schooled him in meekness. A swing breaks a pursuer's forearm, drawing a howl; a stab blows the wind from the brisket of another. The townies grumble and draw back. But others have come in response to their shouts.

Albrecht directs a fighting retreat, but the university is too far and the crowd now too many. Stones begin to fly again and what had begun as a near-amiable thrashing may soon end in riot and murder. Albrecht and Nicole back up a narrow alley, instinctively warding their flanks.

Then the militia are about them: a dozen halberdiers in the livery of the university corporation.

An unworldly scholar or two is one thing; grim-faced men who know how to kill is quite another. The mob breaks up sullenly. One reckless youth hurls a final stone—and is felled by the butt end of a poleaxe. That is the end of it. A few shouted imprecations follow—"staircase wit"—but words are nothing compared to sticks or stones. Albrecht throws his billet-club to the ground. His fingers tremble, but he does not permit Nicole to notice.

The two scholars take stock while the militia escorts them into the university precincts, where university law prevails. A few bruises. A cut on Albrecht's cheek. And Nicole's proud new eyeglasses broken.

"But the glass is intact," Buridan comforts him when he inspects the wreckage later. He seems more concerned for the marvelous invention than for his two students. He had given them but a glance of amusement, and cautioned them against brawling, "unless the numbers be more in your favor." He is more concerned that the militia left the grounds to effect the rescue, something he will now need to square with the Provost of the City. Heytesbury arrives from his rooms, attracted by the commotion and, informed of the circumstances, recounts tales of mighty combats in Oxford town. Hundreds of scholars massed against a like number of townies and armed with tight-packed balls of snow and ice.

"The ice is the worst," he gravely assures them.

Nicole thinks stones worse than ice, and knows a little pride that he has endured such combat. When he tells the kitchen wench later, the size of the mob has swollen and the billet-club is in his own hands. Three downed at a blow! She pretends to believe him.

"You were correct," Buridan tells his senior student after Nicole has parted to rest from his ordeal. "It *is* obvious."

Albrecht blinks. "Obvious that. . . ?" he says, creating an expectant silence for his master to fill.

"That falling bodies exhibit uniformly difform motion. The velocity increases with each increment of distance fallen."

Heytesbury purses his lips. "Obvious to you, perhaps, John. . . ." He also wonders why it has taken the Paris Master a full day to determine the obvious.

"But it is clear from the theory of the impetus," Buridan declares. "What causes a body to fall? Some say that a body's substantial form causes it to fall; but that begs the question. I say it is the body's gravity, its weight. But consider now that a body's weight is constant . . ."

"And yet it clearly moves faster and faster as it falls," Albrecht adds. "So *gravitas* cannot be the cause of the *difform* motion, since an unchanging thing cannot cause a changing thing."

Heytesbury scratches his head. "Proximity to its natural place? The longer the body falls, the closer it is to its place; and so, as a lover rushes as he nears his beloved, it moves faster."

"Unconvincing," said Buridan, dryly. "What else might it be?"

Albrecht tugs on his chin. "Rarefaction?" he suggests. "A body moving through air becomes warm through friction, and warmer air is more rarified and so presents less resistance to the falling body."

Buridan shakes his head. "But no. I will tell you. In the beginning, *gravitas* alone moves the body and it moves slowly. But in moving, the body acquires an impetus. This impetus *together* with its original *gravitas* now moves it. We may call this 'accidental heaviness,' to distinguish it from the body's 'substantial heaviness.' The motion thereby becomes faster; and by the amount it is faster, so the impetus becomes more intense, adding still more accidental heaviness."

Heytesbury is rendered momentarily mute. Then he hollers, "Oswy!" and before he can articulate his desire, his long-suffering servant has appeared and placed a palimpsest on the table before him, proffering a quill. "Ink!" cries the Englishman, a request fulfilled by Albrecht, who, standing by the window, is closest to Buridan's desk. "This parchment is already marked up," Heytesbury complains. "Lend me your razor, John. I need to scrape it off."

Buridan hands him the razor, remarking that it had once belonged to his teacher, before he went off to the Kaiser's court. "A countryman of yours."

Heytesbury blinks, studies the instrument, purses his lips. "Ockham's razor? He certainly knew how to clear a page. Hah!" For the next few moments, Heytesbury makes notations on the sheet. "I must see if there be a way to express your theory in the arithmetic of fractions. Bradwardine has a pleasing notion which he styles 'instantaneous velocity.'"

Buridan had sent Oresme to rest from his ordeal, but he is not in the master's bedchamber when Albrecht comes to fetch him. The Saxon sits upon a stool and considers the possibilities then, shaking his head, he departs for the servants' quarters, where he finds the younger man swyving the serving wench, Lizette. "The master desires to see us," he announces while the two scramble for their clothing. Nicole gives him a dark look and Albrecht shrugs. "He told you to lie down."

"He didn't say 'alone.'"

Albrecht grunts and glances at the young woman, who clutches her coverslut to her. He smiles politely while Nicole pulls up his hose.

"What is it?" Nicole asks as he hops down the hall in the Saxon's wake, tugging on his shoe.

"The Master desires us to contrive an experience."

"I have paid the stationer to copy that section of the Philoponus which deals with contrived experiences," Buridan explains when they have forgathered in the instruction room. "He should have rough copies for you tomorrow. I desire you master that section and contrive an experience, in imitation of Philoponus, to proof whether our Albrecht has correctly described falling bodies."

Heytesbury, sitting to the side at a writing desk, scribbling on parchment with quill and straightedge, speaks without looking up, "Meanwhile, I will employ the compounding of fractions to express all this in mathematical form."

Albrecht says, "I see no reason why the world should be reducible to mere mathematics. In the sensible world, there are no infinite lines, no dimensionless points, no perfect spheres tangent to perfect planes."

Heytesbury turns and lifts his reading spectacles from his nose. "My dear boy . . ." He is but three years Albrecht's senior, but he has determined and incepted and is a Fellow of Oxford. "My dear boy," he says, "Light is the first form that came to primary matter at creation. The entire world thus results from the propagation of luminous species; and, as light propagates rectilinearly as a succession of waves, we can describe it using rays and reflections according to geometrical laws. Hence, to understand the *geometry* of space and time is to understand space and time, what!"

Albrecht is stubborn. "You cannot mean that even the bricks of this building are a form of light!"

Buridan intervenes. "Grosseteste's metaphysics need not concern us. That the world is a consequence of geometry strikes us here at Paris as unduly Pythagorean. Abstractions like rays and numbers are constructs of the human mind and cannot be the efficient causes of sensible facts. No, Master William, it is experience of the senses, not mathematics, that will proof the proposition."

Nicole, listening in unwonted silence, wonders whether the Oxonian and Parisian schools might be united to the benefit of both and the glory of God.

Several days pass while each engages his particular task.

Albrecht and Nicole wrangle with the text. Buridan tries to describe the *propter quid* of freely falling heavy bodies. Heytesbury wrestles with compounded fractions, trying to capture the insights of the physicists in a net of numbers.

If the impetus continually adds increments of gravitas to a falling body, the Englishman reasons, then the body's weight while descending is greater than its weight at rest. Jordanus of Nemours had distinguished between *gravitas secundum situm*, or "positional gravity," and *gravitas in descendendo*, or "freefalling gravity." But that bodies in motion become weightier the faster they move is contrary to experience. Or is it? Who can weigh a body while in motion? To rest on the balance beam, its motion must be arrested, so that if one learns its weight, its speed remains unknown. Whereas, to observe the speed, the body cannot be weighed. . . .

Further, if resting weight and falling weight are distinct, as Jordanus wrote, there must be some as-yet occult form underlying a body's manifest weight, whether falling or no. Something that *informed* weight without *being* weight . . . Interesting. He scribbles a marginal gloss on the page.

Now, motion is the successive accumulation of the form of distance, and difform motion is the successive accumulation of the form of velocity. But *uniformly* difform motion means that *equal* increments of velocity are obtained at each interval, so the incremental impetus must be proportional to the same quantity at each interval. But impetus is proportional to the weight and speed of the body. So, if moving weight is continually increasing, it must be the rest weight that increases the velocity.

But how short is the duration of each interval in which velocity is acquired? Time is a continuum, not a succession of discrete moments, so there is no natural and necessary duration to an interval. Then let the intervals become of shorter and shorter duration. But then in no time, no distance would be covered, and so no velocity would result! Hah!

Perhaps if he considers the shortening of intervals as he had the rarefaction of air between approaching planes . . . He can then define Bradwardine's "instantaneous velocity" as an extrinsic limit. . . . The intervals become shorter *ad infinitum*, but there is no "last" duration . . . Hah! A very pretty problem.

A pretty problem which at times causes him to throw his quill across the room in frustration and to apply his razor to the sheet of palimpsest. If he works the problem much longer, that sheet will be scraped to translucency.

And meanwhile, Albrecht and Nicole pore over two scratch copies of the Philoponus chapter that they have dubbed *On the vexation of nature* and which they have obtained from the stationer. They compare the two copies word for word, correct the spellings and disagreements, rush back to the stationer to consult the original (which the clerks are now rendering in full), identify some likely errors that Cremona himself seems to have made, debate whether a ratio has been carelessly inverted, and generally wrangle over the text. No conclusion should be drawn from a text unless it is faithful to the master's copy.

And meanwhile, Buridan drafts his ideas on uniformly difform motion, incorporating Albrecht's thesis and Heytesbury's sometimes-peculiar suggestions. Let moments approach intervals of no duration? Absurd! Velocity is the ratio of the distance traversed to the time spent, and a ratio over zero is infinite, which would imply that finite motion is infinitely fast at each moment, a foolishness. Heytesbury replies that a duration of zero is *extrinsic* and, as the distance covered also decreases, the ratio remains always finite. After this, he trails off into confusion, or Buridan fails to follow the trail, or both.

One evening, Buridan notices Oresme's broken eyeglasses still lying on the corner of his desk and chides himself for having forgotten their repair. Idly, he holds the new-fangled glass at arm's length to inspect the damage; and, inasmuch as he is wearing his reading spectacles at the time, he is astonished to see a blurred image with the seeming of great distance. Yes, a tiny *ymago* of the building across the street. On a whim, he reverses the two, holding his own lens at arm's length and peering through Nicole's strange new concave glass.

And nearly drops them both. The image now appears large and close, as if the building has toppled in through his very window! Startled, he checks with his own eyes and is gratified to see the structure still in its proper place. The image, then, is mere illusion. He sets the glasses aside and reminds himself to take them to the optician for repair.

Albrecht and Nicole desire to measure the time taken by a falling body to traverse successive distances and, having no notion how this might be accomplished, have decided to consult one who works with time for a living. "A mere artisan," grumbles Nicole as they search out the street of the clockmakers.

"And we have need of his art," Albrecht answers cheerfully. He asks of a man passing in the other direction the name of the most skilled horologist and receives in return the name of Fernand of Quoeux, "the third shop on the right."

Albrecht thanks him, and he and Nicole resume a previous argument.

"If the body rolls down a *ramp*, as Philoponus used," Albrecht says, "then the motion is constrained and not natural. It does not fall free, hence no *gravitas in decendendo*. Why can't we just drop two balls of different weight from the balcony?"

"Because," Nicole tells him again, "the Englishman desires to *measure* the distance fallen and the time taken, and we cannot do that with free fall. It passes too quickly. We must retard the bodies' motions by rolling them down inclines. The Master is confident that the relationship will remain apparent even if the actual velocities are less. Have you never read *On the theory of weights*? Jordanus wrote it when he was old, and corrected all the mistakes in his earlier book. He solved the problem of motion on a ramp, something which the ancients never did. We need only eliminate resistance from the material of the ramp. Grease, perhaps."

Grease . . . He is still wondering why that sufflator moved backward. It seems to him a more interesting puzzle than Albrecht's. Could the method of contrived experience determine *that* question? First, he must repeat the experience to learn whether a common course of nature obtains. Then . . . Then, what?

Albrecht is puzzled by his companion's unwonted silence; but, grateful for the respite, he does not interrupt the young man's thoughts until they have arrived at the clockmaker's shop.

Fernand of Quoeux owns a broad face with thick, pendulous lips and a basset hound's liquid eyes. His hair is white and sparse, save on his lip, where it flourishes. He is engaged in close discussion with Georges the carpenter, who owns a shop on the next street. Nicole is delighted to discover in them two fellow Normans, and they fall into a discussion in which "pockets" replace "sacks" and "hardelles" replace "filles" and they agree that the weather is "muggy" and not, as the French would say, "humid." Albrecht finally interrupts the reunion and explains to the clockmaker what they want and why.

The carpenter has stayed to listen. "Time and distance of a falling body?" he laughs. "Of what use is that to know?"

Nicole and Albrecht are struck dumb. They had never thought of using it for anything. Finally, Nicole says, "So you know how much time you have to get out from under." He does not add "fool" as an address, but the carpenter hears it anyway. He swells like a banty cock, but the clockmaker places a hand on his shoulder to quiet him. Should an argument breaks out, he might lose the work!

"If you would build this inclined plane they want, Georges," he tells his friend, "the payment would be a practical result."

"Pfui! A simple task, mere apprentice work. Not worth my time. How big would you want it?"

Nicole has been thinking about this very matter. "Fifteen or twenty shoes tall. And both the slope and the height of the incline must be adjustable." Albrecht lifts an eyebrow, but says nothing.

Carpenter and clockmaker look at

each other, adding pounds and pennies with an arithmetic skill that would shame the Calculators of Merton. Finally, Fernand asks, with a skeptical study of their robes—for he has been cozened by scholars before—how they would pay for the labor. When they tell them that my sir the Rector will pay for all, their eyes light up and the price is adjusted upward by a compounding of fractions.

Days pass while Buridan awaits the clock, and the ramp grows in the courtyard behind his office. The carpenter and his boys hammer away before an ever-shifting audience of curious scholars, who propose an ever shifting cloud of speculation over its intended use.

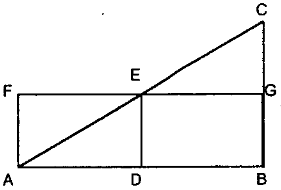
One day, while Heytesbury, Albrecht, and Nicole wait in the Rector's office for Buridan's appearance, the Englishman explains Grosseteste's view of uniformly difform motion. He paces as is his wont—a peripatetic scholar, indeed!—and waves his arms the while. Nicole whispers to Albrecht that the best way to silence the Englishman would be to hold his arms to his sides; and he is prepared to compare the arm motions to those of a bellows, which also forces air out of an orifice, when Heytesbury mentions the Mean Speed Theorem: "Whether a latitude of velocity commences from some finite degree," he explains, "every latitude, so long as it terminates at some finite degree, and so long as latitudes are gained or lost uniformly during some assigned period of time, will traverse a distance exactly equal to what it would traverse in an equal period of time if it were moved uniformly at its mean degree of velocity."

Albrecht is rendered mute as he tries to pierce through the manifest grammar to the occulted mathematics. "So, a body in *uniformly* difform motion," he ventures, "would the same distance cover as it would have covered had it possessed simple uniform motion at the mean speed." Heytesbury nods happily, and Albrecht wonders why this Grosseteste could not have stated it in that manner.

Nicole has been sketching on a scrap of paper. He represents the passage of time with longitude, drawing a line from left to right. The successive latitudes of velocity acquired, he represents by perpendicular lines drawn upward. If increments of velocity are attained uniformly, each line's extension is successively longer by the same amount. He sees that the lines approximate a right triangle. But if the passage of time is a continuum, as even the ancients recognized, he may replace his procession of sticks with the simple triangular figure. The height of the triangle signifies the final form of velocity attained.

He draws a horizontal line whose latitude is half the height of the triangle.

And gasps.



The Englishman is correct in every detail! A few theorems of Euclid and the conclusion follows!

The others come to his side and study what he has drawn. Nicole stammers something about "equal triangles" and "similar sides" but the gist of it is that the area of the triangle ABC produced by uniformly difform motion has precisely the same area as the rectangle ABGF produced by simple uniform motion.

"Then the *area* enclosed by the figure somehow signifies the distance traversed," Heytesbury cries. He stands suddenly erect and turns his head to look off into the distance. "If distance is to time as area is to length . . . Hah! Area is the doubling of length, so distance must be proportional to the double of time! No, by His wounds!" he swears and flies to Buridan's desk, where he seizes the quill and scratches away on palimpsest. "The area of the triangle is half the length of the base doubled by the height, so distance must be proportional to *half* the doubling of time!" He turns in the chair and stares wide-eyed at the two students. "It remains only to discover the constant of proportionality!"

Nicole's mouth drops open. He is mesmerized by an image of geometry and arithmetic blending into a harmonious whole. A unified mathematics! "We could say 'square' the ratio instead of 'double' it," he ventures, applying geometric language to arithmetic.

"Indeed we could," Heytesbury agrees. "But what would we say if we were to compound the ratio *in quarto*? Or reduce it by three-fourths? But . . ."

But whatever thoughts engage his mind are forgotten when Buridan storms into the room. Under his arm, he bears a new copy of the Philoponus; while under his considerable nose, he wears drooping, down-turned lips. As the lips, too, are considerable, the overall effect is one of grave displeasure. "What is it, John?" Heytesbury asks in concern.

The Philoponus thuds to the desk; the Rector, to his seat. "That little Greek catamite," he exclaims, "discovered the impetus! He stole my idea!"

"He's dead, John," Heytesbury informs him. "Long ago."

"I know," The Rector sighs, "but it was a humbling experience, once I realized what Philoponus meant by the 'carrier.' You could have told me!"

Heytesbury spreads his hands. "I didn't realize. I'm a logician, not a physicist."

"He wrote that his *'carrier'* was proportional to the weight of the body, so that a bullet, a cork, and a feather, thrown with the same force, will travel different distances. Once I read that . . . Holy blue! Do you know what most disturbs me?"

"What?"

Buridan raps the book with his knuckles. "That the book was so long lost! Think, William! How far might the philosophy of nature have come had we known of the impetus since Cremona's day?" He shrugs from his elbows in a gesture so Gallic that Albrecht nearly laughs aloud.

"But Master," says Nicole, "surely the Philoponus might have been read by many, but never understood until a mind sufficiently supple considered it!"

Buridan's laugh is froglike. "Well, William, you see that my students learn the most important lesson of all!"

"Permit me to inspect your lips," Albrecht tells Nicole later as they walk the streets to their quarters.

"What? Why? Are they soiled?" The Norman wipes them with a kerchief.

"No," says Albrecht. "I thought they might have turned brown from kissing our Master's arse."

Nicole shoves the laughing Saxon, with no more effect than if he had shoved a tree. Rather it is the Norman who staggers backward a few steps.

"What make you of the Englishman's notion?" asks Albrecht. "That the traversed distance is proportional to half the weight of the body and the doubling—I mean, the 'squaring'—of the elapsed time." He cocks his head, his gaze on some unseen world. "If the body be uniform and the space a void. But would it be true in a plenum and for a heterogeneous body? Suppose we drop two bodies in water? One may fall more slowly than the other depending on its weight . . . A stone and a cork . . ."

Stone and cork? Nicole grabs him suddenly by the sleeve. "Wait!" And the two come to a halt in the crowded street, earning curses from carters and housewives who find their way suddenly blocked. "No, not the weight . . . Think latitude of forms! A *uniformly* difform distribution of forms must result from a single agent. Apply heat to one end of a rod, and the heat in the rod will be difform—the near end hotter, the far end cooler, just as light dims difformly from its source!"

"And . . ." asks the senior, who has grown conscious of the milling stream of humanity parting angrily around them. He gently presses his companion to the side of the street.

"And . . ." Nicole stammers, "and . . . We distinguish the total amount of heat in a body from the intensity of the heat, no? If two bodies of different size contain the same amount of heat, we say the *intensity* of the heat, the 'temperature,' is greater in the smaller body. So if two bodies of different size contain the same *quantity* of gravity, *gravitas secundum numerositatem*, then there must be an intensity of latitude, *gravitas secundum speciem*, a *specific* gravity, that differs between them. What if motion is due to the difference in the *gravitas speciem* between the body and the medium? Your cork . . . A body that falls through air may float on water."

Albrecht grunts. "No, I think the Englishman has right. The answer lies in the difference between rest weight and moving weight. Master Buridan says that, once impressed upon it, a body's impetus is permanent until dissipated by resistance. What if the impetus is naturally in a body, at least in potency, and is only *actualized* by the moving agent? Then weight itself is but the result of a quantity of prime matter and its natural impetus to motion."

"How can a body resting on the ground have motion?" Nicole asks skeptically. So saying, he imparts an impetus to a stone on the dusty lane and it skitters off to strike a mule on the hoof. The mule balks and the muleteer curses them.

"*Potential* motion," Albrecht tells him as they run off. "It *would* have a velocity, toward the center of the world, if the ground weren't holding it back."

The idea is so absurd that Nicole cannot stop laughing until they reach the corner where they go their separate ways. It is only after they have parted, that the Norman recalls his master's answers to Aristotle's objections to the motion of the earth. Suppose, *secundum imaginationem,* that the earth turns with a diurnal motion from west to east. Why do we not feel a consistent easterly wind, *versus* a northerly wind? Why do people not continually stumble as they try to keep their footing on a ground in motion? Why does a stone thrown upward not fall a league to the west if the earth moves eastwardly below it?

Buridan's answer had been that if the air and the people are also moving, the appearances would be saved. The stone, of course, would be pushed to the east by the moving air. Only the Objection of the Arrow had stumped him. An arrow loosed upward cuts through the air and is not borne by it.

But now Nicole sees that Buridan has not pressed his argument far enough! Consider the arrow at rest. If the earth turns, *the arrow is already moving toward the east!* It has a horizontal impetus imparted by the earth, as well as its own natural downward motion. He stares at a loose stone resting in the dusty lane. *It could be moving,* he thinks, *toward the east at many leagues every hour. Like the air, like the people, like the great Ocean Sea. Like me.* It is a heady thought, and it nearly makes him as dizzy as Aristotle once supposed a turning earth ought, until he realizes that he has *assumed* the earth's diurnal motion, not demonstrated it. He has merely completed his master's demonstration that the appearances would be saved whether the earth turned or the heavens.

He stoops to pluck a stone from the lane and, hefting it, tries to *feel* its eastward motion. But he cannot, any more than a man on a ship can feel the vessel's forward motion by placing his hand to the deck. He and the stone are both moving with the same speed and in the same direction. He sighs, deciding that there is no way to demonstrate the proposition by the senses alone. If he were affixed to the orb of the stars and looked down upon the earth, the earth would appear to turn; even as he, affixed to the earth and looking up, sees the heavens turn.

Perhaps he could *make* an experience by "artful vexation of nature." An *experientia facta est,* to coin a phrase. A "fact."

Suddenly exuberant, Nicole hurls the stone high in the air. It comes down, not many leagues westward, but atop the awning of Schmuel the silversmith directly beside him. Schmuel rises from his bench cursing in his outlandish tongue and Nicole laughs and scampers off.

Fernand delivers the water clock to the university precincts the next day. The apprentices wrestle it from the cart to the courtyard that the Rector has chosen for the contrived experience. The carpenters' hammers compete with clockmakers' shouts as they position the device beside the ramp. Curious scholars have formed a circle around the group, laughing and pointing, until the Rector wonders aloud whether the regent masters are waiting to start the *lectiones ordinaria*. Half the regents are themselves in the gawking crowd, but scholars and masters quickly disperse.

Heytesbury arrives and views the large basin with awe. "Why, 'tis a *tunnedish,* i'sooth!" he cries in his own outlandish tongue. "It must hold four *hogs' heads*!"

No one knows what he means and, when it is translated, one of the workmen bristles. "This ain't no slaughter-bucket, begging your pardon, sir! Hogs ain't in it." But the Englishman explains that a hog's head is a measure of volume used in his country and this both placates the men and amuses them with the queer notions of foreigners.

"Explain it to me again," Buridan asks his guest. As a physicist, he is unaccustomed to instruments and making measurements. "The weight of the water is a surrogate for the passage of time?"

"Yes, yes!" Heytesbury exclaims. "That is why master Fernand made the basin so great. Is that not right, my good man?" he cries to the horologist, who has learned to ignore the whirlwind. "As the water in a basin diminishes," he continues to his host, "so too does the weight pushing the water through the orifice; but with so large a reservoir of the water, the press does not sensibly diminish before it can be replenished. Hence, the water will issue forth with a uniform motion, and in equal increments of time we will obtain equal increments of water. As the rolling balls attain each of the distances marked on the inclined plane, we will accumulate the water in a flask, determine its weight, and so approximate the time. Hah! It is really quite pretty!"

Buridan nods. "But yes, I follow your reasoning, but it seems . . . distanced from the direct experience."

"No more than a rule distances the carpenter from the length of his wood."

Fernand shows them the five *faucettes* he has fixed to the basin and instructs them in their use. "First, turn the master faucet," he tells them. "That will start the flow of water down all five channels and begin filling all five flasks. When your ball reaches the first mark, close the first faucet; at the second mark, the second faucet; and so on." He instructs them soberly. Privately, he thinks them mad.

The Englishman tilts his head back. "And what are those contrivances perched atop your basin? Metal birds, what?"

Fernand stands taller. "But I am a master clockmaker, my sir, not a base metalworker. There must be bells and whistles to mark the times! It would shame me to give any less. As the water drains from the basin, the water in—you see that tall thin column? Yes. The water in that column will drop more rapidly, and a float dropping with it will, at the most minute intervals, cause the chirping of the bird." He doubts that anyone other than scholars would ever need such minute times, but the challenge has given him a curious satisfaction. And, who knows? Were he to offer such a feature on his clocks . . .

Heytesbury laughs in delight. "Well done, master clocksman!"

The man shakes his head. "But, my sir, if only you saw the true clocks I have made!" He tugs his forelock and turns again to admonishing the clumsiness of his apprentices.

Nicole and Albrecht arrive, the Saxon flourishing a metal rule—a mason's rod that he has "borrowed" from the nearby construction site. It is a "rule of thumb," with tics in the metal at intervals of one thumb's-length, or *uncias*. "Nicole and I thought to mark the ramp at equal intervals of one shoe—how do you say it?"

"Pied," says Buridan.

"Foot," says Heytesbury. "But be certain to make an especially heavy mark," the Englishman continues, "at the doubling points: one, two, four, eight, sixteen, and so forth. If the mathematics is true, our sphere will reach each of those marks at equal intervals. Oh, had Abbot Richard but lived to see this!" And he hurries off to give unsolicited advice to the workmen.

Will the ramp and basin never be done? The carpenters work their levels and hang their plumbs and hammer wedges into the ramp to ensure its evenness. Water is hauled in buckets from the well and poured into the basin. Some tent canvas is produced to shield the basin from debris that might clog the channels. There is always one more task wanting. Buridan feels at times like Achilles chasing his tortoise: coming incrementally ever nearer without ever quite attaining the end.

So, perhaps there is no last moment of activity; but there is a first moment at which all stands finished.

Georges the carpenter has added a touch of his own. The lever that releases the ball to roll down the rails will also turn the master faucet. Watered by silver, his earlier skepticism has flowered into delighted cynicism. He has suggested a number of improvements to the device, each at an additional cost.

Fernand insists on proving the water flow. "I know she's not a clock, rightly speaking," the man says, "but 'tis what we always do before I place my hallmark. A good clock, the water must flow equally at all times; so we will let the water flow through all five faucets for the same duration. Then you may weigh the flasks to ensure that the same weight of water has issued from each. If not, I have shims to adjust any that are off."

The "calibration" proof is performed and Fernand adjusts nozzles two and five and soon all is in balance. The clockmaker surveys his handiwork, much as God is said to have done after His six days' labor. "This has surely been the most peculiar instrument I have ever made!" Then from his workman's pouch he extracts a metal die and a sledgehammer and with these instruments strikes the mark of his guildhall into the basin.

Buridan has seen such marks in passing his whole life. Perhaps he has even seen them being struck. But he has never seen it done after reading Philoponus, and it is as if he has never seen it before in his life. He grabs the clockmaker's wrist and pries the die from the man's astonished grasp.

"The die is reverso," he says, studying its face.

"Surely!" Fernand snatches his precious hallmark from the Rector and returns it to his pouch. "Otherwise, the hallmark would be backward. We can't have that!"

"What if . . ."

What if . . . Scholars have been accustomed to reasoning *secundo imaginationem* ever since the condemnation of certain propositions of Aristotle more than fifty years before. "What if you made one of these for each letter of the alphabet? Then you could strike any name or word you wish; and if you applied ink to the face, you could press it upon a page and write the same thing over and over, always the same!"

Buridan is a philosopher, not a mechanic, but he realizes that there would be practical difficulties—in casting dies, holding them aligned, and so on; but ingeniators delight in overcoming such difficulties. Bacon's explosive powder, perfected by a Freiburg *ingeniator*, Berthold "the Blackened," has recently been used in the Italian wars. Surely, printing with archetypes can be no more difficult!

When the day comes for their contrived experience, Buridan and his helpers discover that the young scholars of the university have devised a new amusement, in which they themselves slide down the rails. This has produced some splinters in a few arses, which amuses the Rector, and has warped the rails out of true, which does not. He postpones matters, summons Georges and his apprentices to repair the damage, and sets the corporation militia to stand watch over the device.

Having the day at leisure, he goes to fetch Nicole's newly repaired spectacles from Louis the optician, a gray-haired man with bulging eyes. They have been re-polished and affixed into a new frame of steel wire. Buridan asks the fee and the man waves him off.

"That notion of yours has already more than paid the fee," he says, presenting him with a pair of tubes, one sliding inside the other, the whole being nearly an arm's length. Buridan has quite forgotten, and the lensman reminds him. "You told me that looking through this new-fangled glass at a normal lens makes everything seem larger. So I ground me some new lenses and tried for myself. Took some while to get 'em right—they must be planar on one side, y'see. The lens glass being at the far end and the concave glass at the nearer . . ." And he goes on regarding focal lengths and apertures. "But it works just like ye said. Here, you look through the small end, what I call the 'ocular.' That's right, my sir. Then you slide the tubes until everything is sharp."

Buridan laughs with delight when, peering through the window, he sees the goldsmith in the shop across the street polishing a ring that he has crafted.

"I call it a 'look-glass," the gray lensman says. "I let people peek for a *denier* each. You can see the bells in the cathedral tower. There, in the distance between the goldsmith and the apothecary." The scene leaps into Buridan's eye, and he nearly jumps back in alarm.

"It's become popular," the lensman continues. "Four or five people come by each day to see, and some stay to purchase reading lentils, or they bring me their lenses to repair. Some of them tarry too long over the look-glass, though. There's a bawdy house down the street, and I think they hope for a glimpse through its windows. I need a sand-glass to call time on them."

Buridan verifies the presence of the bawdy house, but the windows are shuttered. He tells the optician that Fernand the clockmaker can devise a water clock that raises an alarum at remarkably short intervals and Louis resolves to acquire one. "Then it's the 'alarum-clock' telling them their time is expired, and not me."

Buridan, fearing his own time is expired, returns the tube, but the optician will not have it. "But no, my sir. It is that you must have one, since it was of your suggestion."

The Rector thanks him and leaves the shop, but not before the optician calls him back for Nicole's glasses that he has left behind. On his way home, Buridan pauses at every street and aims the—the *spectum latique*? The *tele skopos*?—at every distant sight. Soon, he has acquired a train of citizens, both curious and amused at the Rector's strange activities.

One of the curious is Marcel Etienne, newly elected provost of the cathedral market. He thinks all scholars unworldly, but also knows the Rector a shrewd magistrate. He prays a glimpse through the tube and Buridan points him toward the church of Our Lady.

"I see nothing but a blur," the clothier complains and Buridan explains about *perspectiva* and focus. The complaint shifts. "But the image, she is greenish. Pfui! She cannot be real."

"That is but a consequence of metals in the glass." Or so Louis had told him. Buridan resolves to write a *tractatus* on the optics of dual lenses.

"Zut!" cries the provost. "Ernst the butcher places his thumb on the balance beam! That is an offence against the rules of the marketplace!" He takes his eye from the tube, looks at it, looks at Buridan. "How much do you want for it?"

"It is a gift to me," the Rector replies. "But Louis the optician can make another for you."

"But this is wonderful! I can police the market without showing myself." He turns to go, stops suddenly and looks about. Then he steps to the banks of the Seine and aims the device downstream, past the Grand Bridge and the floating mills, into the far distance. For a time he studies the horizon and the crowd that has followed him to the riverside strains to see what transfixes his attention.

Etienne closes the far-seer and slaps the tube absently against his palm. "I shall need two," he says to Buridan. "One for my own use; but yes, one also for the Constable of France. Think, my sir the Rector! With such a 'look-glass,' the watchmen can mark the English fleet at many leagues distance, allowing the Constable to dispose his forces to best advantage. My thanks to you, Rector!" And with that, he presses the look-glass into Buridan's hands and dashes off for the glassmakers' district.

* * *

In his quarters once more, Buridan finds his houseguest bent over parchment, explaining some point of mathematics to Nicole Oresme. Buridan gives the bachelor his repaired glasses and shows the look-glass to Heytesbury.

"A marvelous device," the Englishman says after he has gazed in amazement out the window. "Bacon described just such an 'optical tube' in his Great Work: '*And when we wish, things far off can be seen as near, and vice versa, so that at an incredible distance we might see grains of sand.*' He learned of it from his master, Bishop Grosseteste, who wrote in *De iride*: '*This part of perspectiva, when well understood, shows us how we may make things a very long distance off appear as if placed very close, and large near things appear very small, and how we may make small things placed at a distance appear any size we want, so that it may be possible for us to read the smallest letters at incredible distances, or to count sand, or seed, or any sort or minute objects.*' He even wrote that the Milky Way is composed of innumerable minute points of light, like grains of sand, if you can believe such a thing. Hah!." Heytesbury passes the tube on to Oresme. "But of what use is it? Seeing grains of sand from a great distance? Really!"

Buridan tells him how the market provost had seen the cheating of the butcher. "And a sailor, high upon a mast, may spy landfall—or another ship—from a greater distance. So also, a captain approaching battle. Perhaps herbalists may study a woodland to see if the herbs they desire be there or no, and so save themselves the trouble of a fruitless walk."

"But I meant what use it may serve in science."

"Why . . . none I can think of. But you must tell them of this in Oxford."

"Surely! It presents a pretty problem in *perspectiva*!"

"No, Will. I mean, England himself

must know of it. If the battle-captains of England and France can each spy the other's movements well before the contest is joined, there can be no more surprise on the field; and since success in war depends much on surprise, this device will make war that much less likely."

Heytesbury agrees. Although it is of no matter to him whether Plantagenet and Valois make war on each other, it sometimes happens that the common folk come to harm, the Peace of God notwithstanding.

Later, Nicole tells Albrecht and the Saxon shrugs. "It makes naught," he says. "If a captain cannot find victory through surprise, he will do so through numbers. When all own a *blickglas*, armies will but grow greatah."

The day comes at last.

Albrecht has suggested that they test both the same *quantity* of gravity and the same *intensity* of gravity. So they have made three balls: a steel sphere, a second possessing twice the weight, and a larger fashioned of wood but of the same weight as the first.

Heytesbury sends Oswy off to fetch a balance beam while Albrecht and Nicole arrange a table with pen, ink, "scrape-paper" that can be razored for re-use, and crack-pots to hold the paper down in the breeze.

The Paris Master, for his part, watches with growing excitement. This is it. This is the thing. This is what all of them—The Wonderful Doctor, The Angelic Doctor, The Universal Doctor, Pilgrim, Pierre—had been striving toward. Not merely experience carefully noted, but experience artfully arranged. Bacon's *experientia optima*.

He stands like a man afflicted by a basilisk while about him his students direct the servants filling and carrying the flasks to where Heytesbury has set his balance beams. When the first ball—the smaller steel ball—rolls down the ramp, Buridan tells off the time using his own pulse, well aware that it races from the drama of the moment. The ball attains each mark at equal heartbeats. He studies Albrecht. The long, lean Saxon pretends to stoicism, but Buridan sees his hands clench and unclench as he waits for the results. Heytesbury writes some numbers on scraped paper and hands the flasks to Oswy to empty back into the basin.

The next ball is the wooden one—larger than the first, but of the same weight so that its *gravitas speciens* is less. Heytesbury has expressed *gravitas speciens* as the ratio of the total gravity of the body to its volume. If velocity is proportional to the difference in specific gravity between the body and the resisting air, this ball ought to roll slower.

Heytesbury announces the result, to the surprise of the students and masters and the indifference of the servants. (Rolling balls? Weighing water? It is all one to them with the madness of scholars.)

Two balls with equal *quantities* but differing *intensities* of gravity have fallen in the same time. Now it is the turn of the larger steel ball. This one possesses twice the gravity of the first. Nicole hands it up to the servant sitting atop the ladder. He and Albrecht ensure that the master faucet is closed before they open the others. They lay the cam lever in place so that when the ball is released, the master faucet will open. If Aristotle is correct, this ball will fall in half the time as the first. If not, then Philoponus is correct.

The others watch with their breath caught, but Buridan already knows what the result will be. Albrecht's intuition is correct. If anything, the young Saxon had not gone far enough. All heavy bodies must fall at the same speed, regardless of the longitude *or* the latitude of their gravity.

But if the principle governing their fall is constant, it cannot inhere in the spheres, which are varied, for a variable thing cannot cause a constant result. But if not *gravity*, then what?

The ball rolls; the water runs into the flasks.

"*Fui*," Buridan whispers, "*et vidi experiri.*"

That night, the Paris Master cannot sleep. Restless, he rises and paces his room. From down the hall, the sound of Heytesbury's snores. Through the window, the more silent sounds of night. A dog barks somewhere. An owl swoops in a hush of feathers on some incautious mouse.

Earths and waters fall; airs and fires rise. That much is certain. Put dirt and water in a jar and shake it until everything is mixed. Then set it aside. Soon, the air will layer on the water, and the water on the earth. So has Aristotle's hypothesis of natural place been demonstrated by contrived experience.

It is not reasonable that all bodies, of whatever weight, seek their natural place at the same speeds. Yet, he has seen for himself that it is so. And now that he has seen the matter, as it were from a different perspective, he wonders why so many people had thought otherwise for so long. Take two identical bodies and drop them side by side. They will fall with the same speed. Now let them fall closer to one another, and the same result would obtain. Now let only the most minute gap separate them, and still they fall at the same speed. What nonsense to suppose that if they were now joined the joined body would suddenly fall twice as fast!

He picks up the optical tube and smacks his palm with it as he paces. *I will become as bad as William for pacing,* he thinks.

"Suppose, *secundum imaginationem,*" he wonders aloud, "that God has annihilated all material in the sublunar region. . . ." He checks himself, recalling his own reasoning that motion in the perfect and unchanging celestial realm is due to the same impetus as violent local motion. "Suppose God created a void space," he amends his thought experiment. "And suppose there is a single part of earth introduced into it." The particle of earth should move to the center of the world—but *where would that center lie?* Wherever the particle is. So it would *not* move, unless it already had a motion, in which case it would continue to move indefinitely. So let it be at rest. Now let God introduce a second part of earth at rest elsewhere in the world. What manner of motion would result?

Would the second particle of earth rush to the first; or the first to the second? But Nicole has told him of the relativity of motion—an inspired insight! There is no privileged place, so . . . Would each particle rush toward the other, as Aristotle taught different Worlds would do?

Buridan pauses by the window. The night air is cool. A full moon casts everything below into a faerie light of soft, gray shadows. He extends the optical tube and spies on the night. He sees a ghostly dog—perhaps the one he had heard barking earlier—and follows it until it disappears around a corner. On the next street, the night watch patrols. Buridan follows them with the look-glass as they appear through one alleyway after another. Their helmets glow creamy-white in the moonlight. He comes to a lighted window, and sees within a young man and a woman in apparent discord.

Time for bed, he thinks and turns away.

But, no. Perhaps one more, something to gaze on before sleep. He scans the shadow-gathered night and spies topping the church of Our Lady of Paris, the smooth, perfect face of the Moon upon the lunar sphere.

He turns the optical tube to spy it.

So began the *Anno Mirabile*, pregnant with all the years that followed:

Albrecht's observation of the phases of Venus, Oresme's experiences with steam jets, and his blending of impetus and inertia into three natural laws of motion. Buridan's debates with Blasius of Parma and Nicolas of Autrecourt. The printing machine of Georges of Paris. The publication of Oresme's heliocentric system of the world on the very day he was consecrated Bishop of Lisieux. Buridan's famous visit to Avignon and his demonstrations to his old friend, now Pope Clement VI, and to Guy de Chaulliac, the pope's physician, during which he confounded his Aristotelian opponents in those public *obligatios* later titled "Dialectic Concerning Two World Systems."

Later still would come deChaulliac's *small-seer* and the incredible discoveries he made during the Great Death; Marsilius of Inghen's infinitesimal algebra; Cardinal Nicholas of Cusa's quicksilver thermometer and his creation of the first authentic vacuum; Da Vinci's discovery of Uranus and his investigations into electricity with batteries and twitching frogs; Francis Bacon's telephone; and the amazing plethora of inventions—from light bulbs to moving pictures—that spilled from the workshops of the acerbic Galileo Galilei. And not least of all, in 1682, the successful landing on the Moon of the rocket ship *Buridan*, flown by Captain Sir Isaac Newton, and propelled thither by the self-same forces first described by Oresme in his *Experientia cum sufflatores*.

What happens next.

If you stand on the mountain peak of any great age and gaze toward the past, you may spy in the purpled west the jagged range of another great age.

But what if you look to the east? ■

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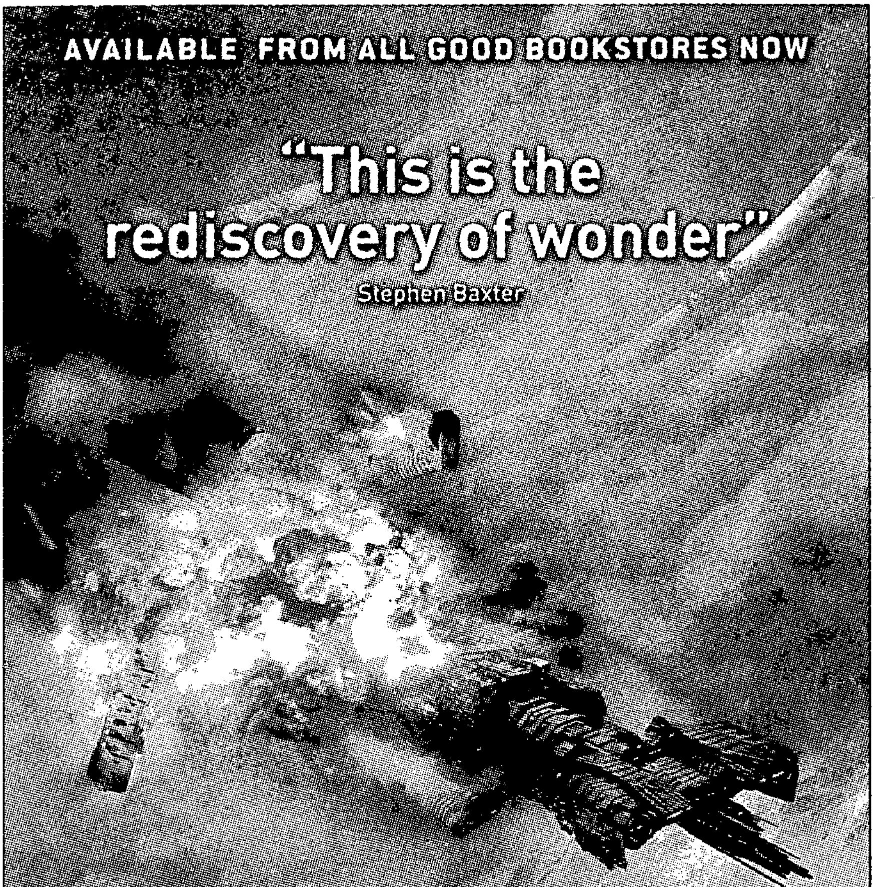

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Science Fact

De revolutione scientiarum in 'media tempestas'

Michael F. Flynn

Note on format: Medieval Questions were arranged for publication into a standard format called the *dialectic*: 1) the **Question** to be determined; 2) the principle **objections** to the Question; 3) an **argument** in favor of the Question—traditionally, a single argument; 4) the **determination** of the Question after weighing the evidence; and 4) the **replies** to each objection. The determination is sometimes preceded by a **definition of terms** or by a **division into separate cases.** The determination was made before arranging the arguments.

Bibliographies were not provided, because the medieval philosopher *would have recognized an entire argument* from a brief quotation. A bibliography is provided here for readers not so blessed.

Question I.
The nature of the Scientific Revolution.

Article 1. Whether there was a Scientific Revolution.

Objection 1. *It would seem otherwise, because* a revolution consists of definitive points of change, and is carried out during a short time according to a plan. But the development of science was continuous and unplanned.

On the contrary, British historian Herbert Butterfield wrote that the Scientific Revolution "outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to the rank of mere episodes . . . within the system of medieval Christendom."

I answer that "Science" is not simply an accumulated body of facts. It is a *methodology* for a) purposefully uncovering those **facts**, b) developing natural **laws** to describe them, and c) formulating physical **theories** to explain them. While the facts accumulate continuously, the methodology had, by the 17th century, undergone a radical transformation involving six "innovative and essential features" identified by Peter Dear:

1. The view of the world as a kind of machine.
2. The distinction between "primary" and "secondary" qualities.
3. The use of deliberate and recordable experimentation.
4. The use of mathematics as a privileged tool for disclosing nature.
5. The pursuit of natural philosophy as a research enterprise.
6. The reconstruction of the social basis of knowledge around a positive evaluation of cooperative research.

Arguably, this revolution was confined to the physics of motion, but spread to chemistry a century later, to biology by the 1920s. (In practice, Darwin was a natural philosopher.) But a gradual sequel does not contradict a sudden advent. Science in our modern sense is only three hundred years old.

But how long was the pregnancy? Pierre Duhem argued that the continuity of the sciences with the medieval tradition was greater than humanist historians had supposed; but he based this on the "pre-discovery" of specific scientific laws like Newton's first law, a procedure subject to accusations of "cherry-picking." Whether Dear's *transformations* also had medieval roots will be explored in the Questions that follow.

Reply to Objection 1. That the Middle Ages contributed nothing to the history of thought is an *idée fixe* of the Modern Ages. Thus, as evidence grew for the medieval roots of much of the Scientific Revolution, so did the argument that there hadn't really been one.

But the Scientific Revolution was as "short and sudden" as the emergence of a butterfly from its cocoon. Those involved were purposefully engaged in overturning previous paradigms. Descartes' *Principles of Philosophy* is perhaps the "Storming of the Bastille." Yet, even if the "revolutionaries" were correct in their self-assessment, revolutions (and cocoons) always have deeper origins. After all, it was never called the "Scientific Coup d'Etat."

"Tipping point" may be a better metaphor than "revolution."

Article 2. Whether the Scientific Revolution was uniquely Western.

Objection 1. *It would seem otherwise, because* Western science grew from Aristotle's natural philosophy. Also, the ancient Greeks proposed atomism and heliocentrism, two themes of the 17th century revolution. Thus, the Scientific Revolution began in ancient Greece.

Objection 2. *Furthermore,* the West was backward compared to Islam, and learned of Greek natural philosophy through Arab intermediaries. Thus, the Scientific Revolution began in Islam.

Objection 3. *Also,* Shen Kua discussed magnetic declination and land formation by deposition and erosion; and maintained daily records of lunar and planetary positions. Thus, China also had a Scientific Revolution.

On the contrary, Stanley Jaki has written that "the Scientific Revolution was stillborn in every other civilization."

I answer that while all peoples and cultures have accumulated "lore, skills, crafts, technologies, engineering, learning, and knowledge," Science is not the mere accumulation of facts. Those facts must be arranged and understood within the context of natural laws and physical theories. But scholars must believe that natural laws are possible before they will look for them. Obstacles to this belief have included:

a) A multitude of self-willed gods. There cannot be consistent natural laws if trees, rivers, and planets are capable of emotions and desires, and sundry gods can intervene in the world to contrary purposes. As Stock writes, "[the Roman's] daily experience led him to believe that nature's forces could be imitated, even placated; he was less sure they could be understood."

b) The absolute autonomy of God.

When even the act of handwriting is ascribed to God's direct intervention, "laws of nature" can be no more than "habits of God," and the reasons for them cannot be comprehended.

c) An infinite sequence of cyclic universes: If the cosmos and its mutations are eternal, all possibilities must eventually come to be, and "laws of nature" are merely temporary concatenations of little significance.

In the Latin West, these impediments were mitigated or absent. The Latins believed that the World has a beginning and an end (i.e., time has *direction*) and that a singular, rational God "disposed all things by measure and number and weight" (Wis. 11:21). By thus revealing His rational nature, wrote Anselm of Canterbury, and because He is faithful to His promises, God has bound Himself to act in a certain way. Such beliefs disposed the Latins to conceive a consistent World, knowable by "measuring, numbering, and weighing."

The Latins made a further, crucial distinction—between primary vs. secondary causation. As William of Conches wrote, "[God] is the author of all things, evil excepted. But the natures with which He endowed His creatures accomplish a whole scheme of operations, and these too turn to His glory since it is He who created these very natures." Later, Albertus Magnus [*De vegetabilibus et plantis*] wrote, "In studying nature we have not to inquire how God the Creator may, as He freely wills, use His creatures to work miracles and thereby show forth His power; we have rather to inquire what Nature with its immanent causes can naturally bring to pass."

They believed that their God had given material bodies the ability to act directly upon one another through their *natures*. Hence, *natural* laws. This "disenchanted" the World. There is no dryad behind the tree, no nymph in the well, only *natures* knowable to human reason. Further, since the heavens, too, are just another created thing (Gen 1:1), and not, as the Greeks and others had supposed, something "alive, divine, and influential in human affairs," the heavens, too, must be governed by natural laws.

That the reasons for material phenomena should be sought in the natures of things, and not in the inscrutable Will of a transcendent Deity—and that these secondary causes are both consistent and rationally accessible—was a uniquely Western worldview.

Reply to Objection 1. The ancient Greeks invented the very idea of "science" (*historiê*, lit., "inquiry"), as well as "nature"—and without that none of the rest would have happened. (You can't have a Scientific Revolution unless there is already a science to revolve!) But *historiê* applied to nature was mostly a non-empirical speculative philosophy. Their criterion for truth was logical coherence more than correspondence to facts. Many, like Plato, doubted the reliability of empirical facts when they conflicted with a really cool logical theory.

Atomism and heliocentrism do not mark an ancient Greek Scientific Revolution for two reasons: a) being outside the mainstream of Greek thought, they *revolutionized* nothing; and b) they were not *scientific* in the modern sense intended here. They were not derived from empirical facts but deduced from logical necessity or assumed *a priori*. Democritus' *atomos* seems prescient only because we apply his term to a very different entity. His five "atoms" corresponded to the five regular solids and five "elements." ("Therefore," the element fire is painful because its tetrahedral atom has the sharpest corners.) Aristarchos placed the Sun in the center "because" fire was a nobler element than earth and rest a nobler state than motion. Aristotle and Archimedes, more empirical than most Greek philosophers, *rejected* heliocentrism because the predicted stellar parallax could not be seen, thus "falsifying the theory."

Aristotle "lit the fire" of Science, although the fuse was uncommonly long. He organized a large body of empirical observations within a coherent philosophical framework, *making Science into a specific discipline.* This had a stunning impact, first on Islam, then on the West.

But Aristotelian natural philosophy, while necessary, was not sufficient: No scientific revolution occurred in Byzantium, which never had to discover or translate it. Few Byzantine scholars added to their heritage, Simplicius and Philoponus being notable exceptions. As Theodore Metochites wrote, "The great men of the past have said everything so perfectly that they have left nothing for us to say." Byzantium did, however, deserve its proud title of "The World's Librarian," and its preservation of ancient learning midwifed both Islamic and Western science.

Reply to Objection 2. Initially, Islam treated Greek learning with greater enthusiasm than had the Byzantine Greeks themselves. However, no Muslim Aquinas ever reconciled Aristotle with Holy Qur'an. The great Islamic *faylasuf* who embraced the Stagerite—e.g., ibn Sinna, ibn Rushd—embraced him all the way, becoming heretics to Islam. Those who rejected him—e.g., al-Ghazali—rejected him completely. The *faylasuf* prospered only under the protection of powerful rulers; and their writings found readier audiences in Western Christendom than in Islam itself.

Islam denied secondary causation. According to Maimonides [*Guide to the Perplexed*], Islamic theologians asserted "when a man moves a pen, it is not the man who moves it; for the motion occurring in the pen is an accident created by God in the pen. Similarly the motion of the hand, which we think of as moving the pen, is an accident created by God in the moving hand. Only God has instituted the habit that the motion of the hand is concomitant with the motion of the pen, without the hand exercising in any respect an influence on, or being causative in regard to, the motion of the pen." Unlike Anselm of Canterbury, ibn Hazn claimed God need not even be faithful to these "habits." Al-Ghazali wrote in *Tahafut al Falasifa [The Incoherence of Philosophy]*, "The imponderable decisions of God cannot be weighed by the scales of reason." Ibn Rushd countered with *Tahafut al Tahafut [The Incoherence of the Incoherence]*, but in 1195 he lost all his offices and was exiled from Marrakech. As "Averröes," his popularity in Europe was second only to Aristotle, but little noteworthy science was created in Islam after his time.

"The problems of physics," wrote Ibn Khaldûn, "are of no importance for us in our religious affairs or our livelihoods; therefore we must leave them alone." An exception was the "practical sciences" of astronomy, medicine, etc., where Muslim scholars made outstanding contributions of *facts*. But *laws* of nature and explanatory *theories* smacked of men limiting God's autonomy.

At the dawn of the Middle Ages, Islamic science did outshine the Latin West; but by the close, their positions had reversed. Yet, without the Islamic translations and commentaries, modern Science would have been long delayed.

Reply to Objection 3. China had a scientific revolution in the 17th century when Jesuit missionaries introduced Western mathematics, heliocentrism, and . . . translations of Aristotle's natural philosophy. (That old Greek sure did get around.) Their revolution was the realization that there was such a thing as "Science." If the Muslims never had an Aquinas, the Chinese never had an Aristotle. They had never integrated the study of the natural world into a coherent philosophy, as Aristotle and his Islamic and European successors had done. Poetry, physics, gardening and alchemy were all *ko-chih*. In effect, while the Chinese had *sciences*, they did not have *Science*.

Far from seeking causes in the natures of things, Chu Hsi argued that one should seek principles in the outside realm in only thirty to forty percent of cases; otherwise, moral principles should be sought within. Even this was too much for Wang Yang-ming, who criticized Chu Hsi's "externalist" views. Sivan described Chinese thought thusly: "Empirical knowledge is neither certain nor probable, merely given. . . . For certainty one looks to illumination, introspection, and other alternatives to purely cognitive processes. Certainty is, in the last analysis, a spiritual and moral stance."

The sages were more concerned with identifying the current point on the cosmic cycle than the natural causes of material phenomena. Sequence, frequency, quantity, and magnitude held little interest. Fang Yi-zhi [*Little Notes on Principles of Things*] wrote that sound and light "are always more subtle than the 'number' of things," i.e., than their measurement. Regarding heliocentrism, Juan Yuan wrote, "Our ancients sought phenomena and ignored theoretical explanation . . . It does not seem to me the least inconvenient to ignore Western theoretical explanations and simply to consider facts." If the Greeks valued logical theories more than facts, the Chinese prized facts with little concern for explanatory theories.

This "follow-the-procedure" approach had consequences. During the Huang-yu reign of Northern Sung, Shen Kua noted that candidates preparing essays on astronomical instruments "were so confused about the celestial sphere, and the examiners themselves so ignorant of the subject, that all candidates were passed with distinction." His proposal for daily records of planetary positions was sabotaged by his own staff, who simply made up the data.

Chinese arithmetical astronomy at its peak (AD 1300) had not achieved the accuracy of Ptolemy's geometric astronomy a millennium earlier. Three centuries later, the Ming calendar "was regularly failing," yet the Directorate of Astronomy resisted Hsing Yun-lu's reforms—not on technical grounds, *but as sedition*. A public admission of calendar failure amounted to a declaration that the dynasty had lost the Mandate of Heaven, tantamount to a call for revolution.

Question II.
The medieval embrace of science.

Article 1. Whether the Middle Ages were an Age of Reason.

Objection 1. *It would seem otherwise, because* the Middle Ages were the "Age of Faith," and faith is opposed to reason.

Objection 2. *Furthermore,* in the Middle Ages "ignorance [was] acceptable to God as a proof of faith and submission." Only in the Renaissance did Europe "awake, bathe, and begin thinking again."

On the contrary, Adelard of Bath [*Quaestiones naturales]* writes , "It is through reason that we are human. For if we turn our backs on the amazing rational beauty of the World we live in, we should indeed deserve to be driven therefrom, like a guest unappreciative of the house into which he has been received."

I answer that the medievals valued reason so highly that they applied it to their own religious beliefs, and held God Himself to act reasonably. Both Renaissance humanists and Protestant reformers, for different reasons, accused the scholastics of *too much* reliance on logic and reason.

This Western fascination with reason grew in three stages. During late antiquity, Christianity had to deal with a living, dominant pagan philosophy. As Augustine [*De Genesi ad literam*] wrote, "It is a disgraceful and dangerous thing for an infidel to hear a Christian, presumably giving the meaning of Holy Scripture, talking nonsense on [natural philosophy].”

Later, in the cathedral schools, John Scotus Eriugena, Thierry of Chartres, Gerbert of Aurillac, and others taught from the Roman encyclopediasts and from the “Old Logic” of Boethius. Bernard Silvester laid out the lawfulness of nature, the taxonomy of the sciences, and the necessity of secular studies for Christian education.

Finally, the Latins discovered the natural philosophy of Aristotle. Not *re*-discovered. The Romans had never translated those books in the first place. (Boethius had begun the attempt, but had completed only some of the logic treatises before his execution.) Intrigued by references in the encyclopedias, the medievals flocked to Toledo and Sicily, once the jihad had ebbed, and learned Arabic and Greek to translate these works.

To be sure, Bernard of Clairvaux famously opposed Peter Abelard over the application of reason to matters of faith, but his was a minority position and was not a condemnation of reason itself. By the eleventh and twelfth centuries, logic and rationality had become “permanent and characteristic features” of the Latin West. Grant writes that this “widespread, conscious reliance on reason and reasoned argument seems to have had no counterpart in any other civilization about which we have any knowledge.”

Adelard of Bath [*Quaestiones naturales*] summed matters up in this rejoinder to his nephew: “[T]he natural order does not exist confusedly and without rational arrangement, and human reason should be listened to concerning those things it treats of. But when it completely fails, then the matter should be referred to God. Therefore, since we have not yet completely lost the use of our minds, let us return to reason.”

Reply to Objection 1. That faith is opposed to reason is a modern dogma accepted on faith. The medievals thought differently. Augustine had written [*Contra Faustum manichaeum*], “In the Gospel we do not read that the Lord said: ‘I send you the Holy Spirit so that He might teach you all about the course of the sun and the moon.’ The Lord wanted to make Christians, not astronomers. You learn at school all the useful things you need to know about nature.” Centuries later, William of Conches wrote [*Gloss on Boethius*] that the authors of Scripture “are silent on matters of natural philosophy, not because these matters are against the faith, but because they have little to do with strengthening it, which is what these authors were concerned with.”

Reply to Objection 2. Modern impressions of the Middle Ages stem from the uncritical acceptance of distortions in the works of Luther, Galileo, Voltaire, and others. But Cantor writes that “[t]he image of the Middle Ages . . . at any given period in early modern Europe tells us more about the . . . intellectual commitments of the men of the period than it does about the medieval world itself.” The myth of “a superstitious and credulous Europe giving way to a cool, rationalistic, scientific Europe” is a caricature. Remember, a millenarian panic occurred over Y2K, but not over AD 1000.

Article 2. Whether medieval philosophers were free to inquire into nature.

Objection 1. *It would seem otherwise because* Draper writes, “the Roman ecclesiastical system, like the Byzantine, had been irrevocably committed to an opposition to intellectual development. It crushed the mind.”

Objection 2. *Furthermore,* in 1231, a papal commission was ordered to purge of error the works of Aristotle. And in 1277, the bishop of Paris condemned 219 Aristotelian propositions, many concerned with natural philosophy.

Objection 3. *Also* the Church taught the earth was flat, forbade human dissection, etc.

Objection 4. And what about Galileo?

On the contrary, Gregory IX [*Parens scientiarum]* wrote to the University of Paris that, excepting theology and canon law, "we grant to you the right of making constitutions and ordinances regulating the manner and time of lectures and disputations . . . who are to lecture and at what hours *and on what they are to lecture* . . ." [emphasis added]

I answer that only in the Latin West did Science find an independent, self-governing "home base" free of nearly all hindrances; namely, the Universities. Some of these developed from the earlier cathedral schools (Paris, Bologna), others from informal gatherings of scholars (Oxford, Cambridge). They possessed licensed faculties, standard courses, lectures, examinations and degrees, undergraduate and graduate studies, even the robes and funny hats we wear today. Their workings are described in Grant, Kibre/Siraisi, and Lindberg.

The late Berkeley chancellor Clark Kerr once said that about eighty-five medieval institutions "still exist today in recognizable forms, with similar functions and with unbroken histories." These include "the Catholic church, the Parliaments of the Isle of Man, of Iceland, and of Great Britain, several Swiss cantons, *and seventy universities*. Kings that rule, feudal lords with vassals, and guilds with monopolies are all gone. These seventy universities, however, are still in the same locations with some of the same buildings, with professors and students doing much the same things, and with governance carried on in much the same ways." They persevered through plague and war. It was one of Europe's finest achievements.

The use of reason was uniquely widespread in medieval Europe because the undergraduate curriculum consisted almost entirely of logic, reason, and natural philosophy. Arts and humanities were not taught. As today, most students settled into non-academic lives. Never before *or since* has such a significant portion of a population been educated so systematically in purely analytical disciplines.

Since the graduate schools of theology, law, and medicine required the undergraduate degree to matriculate, *nearly every medieval theologian had first been trained in natural philosophy.* This had important consequences for the acceptance of science by the medieval church. "Despite the 13th century controversies," writes Grant, "medieval theologians did not oppose Aristotelian natural philosophy *per se*. Even people like Bonaventure recognized its utility, and theologians in general were among its staunchest supporters." Indeed, many churchmen (Aquinas, Grosseteste, etc.) themselves pursued natural philosophy. Significantly, they did not cite dogma to demonstrate their conclusions, holding that an appeal to faith was not a philosophical proof.

Natural philosophers "pursued knowledge about the universe in a remarkably secular and rationalistic manner," writes Grant, "with little intervention from the Church and its theologians . . ."

Reply to Objection 1. Draper's polemic is not taken seriously by historians. Thirty-three of eighty-one medieval universities had papal charters, and another twenty had both papal and imperial charters. Chartering nearly two-thirds of all universities and allowing them to determine their own lecture contents seems an odd way of crushing the mind. *Parens scientiarum* has been called by some "the Magna Carta of the Universities."

Reply to Objection 2. The 1231 papal commission never filed a report and the expurgation was never carried out. The 1277 ban applied only to the University of Paris and was in place for only a short time. Aristotelian works were never banned at Oxford or elsewhere, save briefly at Toulouse. The ban represents an overreaction to a faculty dispute, not a general attitude toward natural philosophy.

Some of the condemned propositions—[§154] "That philosophers are the only wise people in the world,"—speak for themselves. So does the so-called "double truth" that a proposition may be true in philosophy, but false in religion. The Church insisted that truth was singular, and if theology and philosophy disagreed, one or the other (or both) was not yet properly understood.

Many of the condemned propositions fall into a few repeated themes:

[§98] that the World is eternal,

[§49] that there cannot be a vacuum,

[§34] that there cannot be multiple Worlds,

[§140] that there cannot be attributes without substance (no "white" without a "white thing")

Theologians argued that the universe did have a beginning (and would have an end). Also, since God could do anything short of a logical contradiction, anything that was not contradictory was at least possible and could not be eliminated *a priori*. In particular, God *could* have created a vacuum, and as many Worlds as He pleased. Thus, the World is contingent, not necessary, and natural laws must be learned through experience.

That attributes can exist without substance is the basis of the Eucharist—hence, the bishop's objection—but it is also the basis of empty Newtonian space, which possesses the attributes of dimension without the substance of an extended body. (How can there be "length" without an "elongated thing"?)

The Condemnation marked the only major irruption of medieval theologians into natural philosophy, and had a paradoxical consequence. The Byzantines, Muslims, and Latins had encountered in Aristotle a fully articulated schema of mesmerizing scope and complexity. The Condemnation broke the spell. ***The Stagerite might not have gotten everything right.*** If he was wrong in theology, might he also be wrong in philosophy?

Albertus Magus devoted a chapter of his *Summa theologica* to the errors of Aristotle: "Whoever believes that Aristotle was a god, must also believe that he never erred. But if one believes that Aristotle was a man, then doubtless he was liable to error just as we are." The notion grew, writes Wallace, that "Aristotle's views had to be examined critically, corrected, reformulated, and sometimes rejected entirely, not only when they conflicted with theology, but also with the manifest data of experience."

No great spurt of non-Aristotelian thinking—dare we say "null-A"?—followed immediately after 1277, but philosophers gradually began to reason, *secundum imaginationem,* regarding the possibility of void space and motion through it, of multiple worlds, and so on.

By empirical observation, sublunar spaces are "stuffed" with earth, water, air, or fire. So Aristotle reasoned that the heavens were stuffed with an aether. Motion is the ratio of force to resistance; a void lacks resistance; therefore, motion in a void would be instantaneous—an impossibility. QED. "Empty space" (hence, Newtonian mechanics) is impossible to an Aristotelian.

But Walter of Burleigh reasoned from Eucharistic doctrine that empty space was possible. Bradwardine dismantled Aristotle's model of motion using compound fractions and a new idea: "instantaneous motion." Buridan found the aether unnecessary and concluded that motion in a void was finite and would continue indefinitely unless opposed. Albert of Saxony determined that bodies of different weights would fall at the same speed in a vacuum. By the late 14th century, scholars had significantly altered natural philosophy.

Gimpel states that the Condemnation had a stifling effect on thought; other historians, that it had no effect; but Pierre Duhem famously called 1277 "the birth-year of Science" (making 2007 Science's 730th birthday!) Hyperbole, yes, but with a grain of truth.

Reply to Objection 3. All ancient societies forbade human dissection, save Egypt (where the Romans outlawed it). Yet, its introduction in the West at the end of the 13th century went unopposed by Church authorities. *De sepolturis* (1299) did not prohibit anatomical dissection, but the practice of boiling the flesh from Crusaders' bodies to ship the bones home cheaply. Attendance at dissections was *required* of medical students at Padua and elsewhere, and the first textbook based on dissections was Mondino de'Luzzi's *Anatomia* (1316), shortly after the bull that supposedly forbade such things. The Pope's physician, Guy de Chaulliac, could hardly have written *Chirurgia magna,* a widely translated manual for dissections, if the practice were forbidden by his boss.

Every medieval reference to the earth, including those in popular sermons, calls it a sphere (e.g. Aquinas, *Summa theologica* I.1, *Reply Obj.2*). The flat earth myth is a modern myth.

Reply to Objection 4. Galileo is the poster child precisely because he is exceptional. But he did not live in the Middle Ages and is outside the scope of these Questions. *No medieval philosopher was ever prosecuted for a conclusion in natural philosophy.*

Article 3. Whether the Middle Ages saw technological advances.

Objection 1. *It would seem otherwise because* Manchester writes that "no startling new idea or significant invention" (other than the windmill and watermill) was introduced in the entire Middle Ages.

Objection 2. *Furthermore,* European technological advances often originated elsewhere.

On the contrary, White says that "[t]he chief glory of the later Middle Ages was . . . the building for the first time in history of a complex civilization which rested not on the backs of sweating slaves and coolies but primarily on non-human power." And that "the four centuries following Leonardo . . . were less technologically engaged in discovering basic principles than in elaborating and refining those established during the four centuries before Leonardo."

I answer that technological progress supplied philosophers with new phenomena to ponder and accustomed society to the idea of progress. Already by the early Middle Ages innovation was conceived as an obligation from God. Hugh of St. Victor [*Didascalion*] wrote, "man's reasoning shines forth much more brilliantly by inventing these very things than ever it would have had man naturally possessed them." A tipping point was reached in the 12th century mechanical revolution. A new term appeared: *ingeniator* (engineer)—earliest citation: 1170, at Durham: *Ricardus ingeniator, vir artifiosus.*

The Latins invented deliberate technological innovation through research: They began to *envision* novelties and attempted systematically to achieve them. Some efforts were successful—the mechanical clock—other, less so—perpetual motion machines. But the *idea* of innovation became embedded in Western thought.

Robert the Englishman noted this deliberateness in 1271, when he wrote that clockmakers were "trying to invent an escapement which will move exactly as the equinoctial circle does; but they can't quite manage the job. If they could, they would have a really accurate time-piece." By the mid-14th century, Europeans were raising intricate clocks in their public squares. By the 15th century, they had invented spring-driven *portable* clocks. By the end of the era, pendant clocks dangled on lanyards from the necks of the wealthy.

Ingeniators were not ashamed of manual labor. Great clockmakers like Henry Bate and Giovanni de'Dondi *boasted* of building their clocks "*manu complevi propria.*" After all, their very religion was founded by carpenters, fishermen, and tent-makers, so they could not regard working men with the same contempt as had the ancients. Indeed, labor was accorded dignity. (A drawing by Herrad von Landsberg in her *Hortus deliciarum* shows Christ himself assisting a husband-wife plough-team.) In the towns, workingmen and their guilds enjoyed political power and the right to bear arms. This attitude proved invaluable when it came time for *labor*atory experiments.

Reply to Objection 1. In no particular order: camshafts, verge-and-foliot escapements, mechanical clocks, eye glasses, wheeled plows, hydraulic hammers, toothed wheels, transmission shafts, steam blowers, blast furnaces, treadles, spinning wheels, trebuchets and mangonels, crossbows, flying buttresses, stained glass, elliptical arches, cranks, overhead springs, coiled springs, horse collars, gunpowder and *pots de fer*, the mizzen mast, the compass rose, portolans, stern rudders, anaerobic curing of fatty fish ("pickled herring"), double entry bookkeeping, screw-jacks, screw presses, printing presses . . .

For information on medieval technology, see White, Gimpel, and Gies/Gies.

Reply to Objection 2. Europeans were no more inventive than others. Some of the above inventions originated elsewhere—the spinning wheel in Syria—or were independently invented elsewhere. What was new in the Latin West was not inventiveness *per se*, but its social context. "The failure of Greece and Rome to increase productivity through innovation," writes Stock, "is as notorious as the inability of historians from Gibbon to the present to account for it." Only in Europe were inventions deliberately pursued and extensively exploited as labor-saving devices—perhaps owing to the disappearance there of slavery.

The Latins didn't worry whether inventions were "permitted." While Ottoman muftis fretted over whether public clocks were *halal* or *haram* before banning them in 1560, the Europeans built them everywhere. "No European community," says White, "felt able to hold up its head unless in its midst the planets wheeled in cycles and epicycles, while angels trumpeted, cocks crew, and apostles, kings, and prophets marched and countermarched at the booming of the hours."

These great public clocks were not built for pious deception, like the automata in Hellenistic temples, nor, as in Byzantium and China, to enhance awe of the emperor; but—again quoting White—"were presented frankly as mechanical marvels, and the public delighted in them as such."

This delight in marvels prefigures the modern idea of "scientific progress."

Question III.
The medieval advancement of science.

Article 1. Whether medieval natural philosophers saw the world as a kind of machine and therefore sought natural explanations.

Objection 1. *It would seem otherwise, because* one cannot discover natural laws if "God did it" explains everything.

Objection 2. *Furthermore,* the medievals explained actions by the object's internal nature. Glass breaks because it has a "brittle nature." But this nature can be learned only through the object's actions, and circular explanations are not explanations.

Objection 3. *Furthermore,* the medievals believed that the natural world is purposeful, and objects move to their natural ends. But purpose lies in the future and natural causes must precede their effects.

On the contrary, Oresme [De causa mirabilium] writes, "I propose here . . . to show the causes of some effects which seem to be miracles and to show that the effects occur naturally . . . There is no reason to take recourse to the heavens, the last refuge of the weak, or demons, or to our glorious God, as if he would produce these effects directly . . ." And Bishop Oresme was no slacker in theology.

I answer that the term *machina mundi*, "the machine of the world," was already common by the 12th century. And Oresme [*Livre du ciel et du monde*] used the clock metaphor three hundred years before the Scientific Revolution: "The situation [God creating the heavens and establishing their regular motions] is much like that of a man making a clock and letting it run and continue its own motion by itself . . . so that all the wheels move as harmoniously as possible."

Belief in secondary causation had, in Grant's words, "transformed Nature from a capricious and willful universe into an orderly, lawful whole accessible to the human intellect." God is the author of natural laws, the thinking went, but the laws themselves could be understood in natural terms.

Nicholas of Autrecourt argued that knowledge based on experience was uncertain because tomorrow we might have a contrary experience; but Jean Buridan responded that truth was attainable from experience "provided a *common course of nature* obtains." Conclusions could be accepted because "they have been observed true in many instances and false in none," and bizarre exceptions could be treated as exactly that.

Reply to Objection 1. William of Conches wrote, "[They say] 'We do not know how this is, but we know that God can do it.' You poor fools! God can make a cow out of a tree, but has He ever done so? Therefore show some reason why a thing is so, or cease to hold that it is so."

Aquinas wrote that reason could be applied to theology, *but revelation was forbidden to philosophy*. His insistence that faith and reason were both independent *and* in concord was influential.

Reply to Objection 2. To paraphrase the objection: The formal cause of falling bodies is an inner nature called "gravity" possessed by matter, but the *nature* of gravity can only be known through the *behavior* of falling bodies. (Newton agreed [*Principia Mathematica, General Scholium*].) Likewise, in evolution, reproductive success is due to an inner nature called "fitness," but fitness can be known only through reproductive success. These explanations are as circular as Aristotle's brittle nature of glass, but are not discarded on those grounds.

In Aristotelian terms, the nature of an object cannot be fully known unless four *aitia* are understood. The static *aitia* (Matter and Form) explain a thing's *being*; the dynamic *aitia* (Agent and End) explain a thing's *becoming* (i.e., motion/change). Only Agent (effective cause) is a "cause" in the modern sense; so the objection is merely that formal causes are not efficient causes, which of course they are not.

The medievals recognized that extension was common to all objects, and to this they gave the name of "prime matter," which possesses dimension, but no substantial form. Substantial form actuates prime matter to a specific nature: the form of oxygen, the form of a dog. All dogs share the substantial form of a dog, but differ in color, size, etc. These latter are called *accidental forms* or *accidents*. For details on natures and Aristotelian natural philosophy, see Wallace.

Formal causes did not disappear simply because they were disregarded any more than logic disappeared because the Renaissance deemphasized it. Now that we call them "atomic structures," "genomes," and the like, formal causes are better understood. When Feynman said, "Electrons behave . . . in exactly the same way as photons; they are both screwy, but in exactly the same way," he was recognizing that both species share a substantial form. Oxygen and carbon consist of identical matter (neutrons, protons, electrons), but possess different natures because of their *formal* arrangements. An electron in a carbon atom does not behave as a free electron; rather, its behavior is controlled by the *form* of the carbon atom as a whole. When we say that glass breaks because of its "amorphous atomic structure," we cite a formal cause, not an efficient one. The amorphous structure doesn't *make the glass break*; it's what *makes the glass breakable*. (And we still don't know how: *3rd International Workshop on the Flow and Fracture of Advanced Glasses)*. Similarly, the formal cause of a dog is its "genome," while its efficient causes are the chemical and biological reactions that "unpack" and express that genome "in a manner harmonious to its environment."

The importance of "emergent properties" and "self-organization" in modern science—inherent in Aristotelian formalism—suggests that rejection of Aristotle's second *aition* may have been premature.

Reply to Objection 3. Final causes are sometimes called "purposes," but *telos* or "End" need not be consciously purposeful. A falling rock does not *intend* to minimize its gravitational potential; a species does not *plan* to become more fit for its niche; a puppy does not *strive* to become an adult dog. But each will move toward these natural ends, provided they "run true to form." Potential functions and strange attractors are teleological. Considering their importance in modern physics—and the difficulties in applying efficient causes alone to quantum entanglement—rejection of *telos* may also have been premature.

Article 2. Whether the medievals distinguished primary from secondary qualities, assigning the latter to the perceptions of the subject.

Objection 1. *It would seem they did not because* the distinction derives from atomism, which Aristotle rejected as self-contradictory. The medievals held that an apple is red, or round, or tart, or falls with a rectilinear motion onto Newton's head without any sense that these were not all equally objective properties.

On the contrary, Oresme [*Traité du ciel et du monde]* writes, "One cannot demonstrate by any [sense] experience whatever that the heavens are moved with daily movement, because . . . if an observer is in the heavens and sees the earth clearly, the earth would seem to be moved; and if the observer were on the earth, the heavens would seem to be moved. The sight is not deceived in this, because it senses nothing except movement. But if it is relative to any such body, this judgment is made by the senses from inside that body, as Witelo stated in his *Perspectiva;* and such senses are often deceived . . ."

First, the distinction must be made. Galileo [*Il Saggitore*] says, "tastes, odors, colors, etc., so far as their objective existence is concerned, are nothing but mere names for something which resides exclusively in our sensitive body, so that if the perceiving creatures were removed, all of these qualities would be annihilated and abolished from existence." These were called "subjective," or "secondary" qualities. Length, weight, position, etc., without which Galileo found it impossible to imagine an object, were called "objective," or "primary" qualities.

Atomism supposed that all phenomena were due to the "shape, arrangement, and motion" of identical, invisible particles. Hence, only mathematical qualities like length or weight could "really" exist in the object. Since we cannot assemble a red apple from an arrangement of colorless particles, color [and other secondary qualities] must be an effect of the extended matter on the subject's mind.

I answer that natural philosophy tried to explain the world *as perceived by humans* and this commitment to empiricism compelled scholastics to consider color, sound, etc. as real. The medievals conceived *prime matter* as formless but possessing extension, that is, possessing only primary, objective qualities. They further approached subject/object duality in *perspectiva* and in nominalism.

The medieval science of *perspectiva* combined the physics of light, mirrors, and lenses with the biology of the eye and the psychology of perception. The difference between Kepler's *Optics* and Witelo's *Perspectiva,* Smith explains, lies not in their geometric analysis of image formation on the retina—identical in both books—but in that Kepler was analyzing *light* while the perspectivists were analyzing *sight*.

In Thomistic psychology, an apple's redness has real, "extensive" existence in the object. Light, by reflection, transmits the form of redness to the brain, creating an image with "intensive" existence in the subject. But extensive/intensive is not the same as objective/subjective. The medievals believed the senses were impressed by something real in the object. The apple *really is* red, and would remain red, *even if no one saw it*.

In the debate over universals, ***nominalism*** distinguished entities having real existence from mere names (*nomines*). *This* chair and *that* chair have real existence, but the species "chair" is only a convenient term that supposits in a sentence for any and all particular chairs. William of Ockham justified this using his famous razor to "erase" unnecessary entities, reducing them to "mere names." Galileo's claim that secondary qualities are "mere names" followed this tradition.

Atomism nudged philosophers away from Aristotle toward Plato's ideal forms; viz., abstract mathematical properties and geometric arrangements of invisible particles. This disconnected science from empiricism, making science, literally, almost sense-less. Berkeley took one step further, proposing that even *primary* qualities were subjective, which aroused Samuel Johnson to his famous contra*punt*al refutation. But Berkeley may have been on to something. Ask Schrödinger's cat.

Furthermore, if redness is only a subjective impression produced in the individual mind, it is impossible to speak of two people seeing the same "red." Subject/object dualism thus subverts the very idea of a knowable objective world. Yet, the simplified world of positivism, though severely battered nowadays by quantum theory, may have been necessary for the adolescence of Science.

Reply to Objection 1. The medieval realists agreed with the atomists that matter was granular, but disagreed on the nature of the granules: Their ***minima naturalia*** were "the least natural parts [of a body] which mingle and interact." Minimists did not make the primary/secondary distinction because their version of least particles did not require it.

Atomist particles are indivisible ("atomos"), not only in practice but in principle. They are made of identical stuff, differing only in size and shape, and do not possess the secondary qualities of the macroscopic body they comprise, such as color.

Minimist particles are ***divisible***, though there is a smallest quantity of each substance *beyond which the form of the substance can not be sustained.* The minima of water is the smallest particle *of water*. Divided further, it ceases to be water and becomes . . . oh, let's say, hydrogen and oxygen. Minimae are as different as the substances they form and do possess the secondary qualities of the macroscopic body they comprise.

If "indivisibles" have shapes, Aristotle countered, then they have parts, and are divisible, a contradiction. Indeed, modern science supports Aristotle: atoms do consist of parts: electrons, protons, and neutrons, and we have actually learned how to divide them in practice. Protons in turn are composed of quarks; and quarks are . . . When Dalton re-imagined the atom, he argued that the atoms of different substances, e.g., gold and silver, had different properties, as the minimists had always claimed. His biggest opponents were die-hard orthodox atomists!

So, the modern concept of atom, greatly influenced by minimism, is a far cry from the identical corpuscles that forced subject/object dualism on Galileo, Descartes, and Hume. A minimist "atomic" theory might not need to separate the observer from the observed.

Article 3. Whether medieval natural philosophers used deliberate and recordable observation and experiment.

Objection 1. It would seem otherwise because Galileo [*Dialogues on the Two Chief Systems of the World*] causes Simplicio the Aristotelian to say, "You have made me see the matter so plainly and palpably, that if Aristotle's text were not contrary to it . . . I would be forced to admit it to be true." Thus, the medievals relied on texts and authorities rather than on observation of nature.

On the contrary, Pierre of Maricourt [*Epistola de magnete*] writes, "an investigator diligent in the use of his own hands . . . will in a short time correct an error which he would never do in eternity by his knowledge of natural philosophy and mathematics alone." Roger Bacon [*Opus maius*] writes, "Nature reveals herself more readily under the vexations of art than when allowed to go her own way." Likewise Albertus Magnus [*De vegetabilibus et plantis*] states, "Experiment is the only safe guide" and often adds, "I was there and saw for myself."

I answer that medieval natural philosophers were careful observers of nature and often cited *evidentia naturalis* to support their determinations, but these observations were seldom quantified and more often cited common experiences than deliberate experiments. Bacon determined that light was faster than sound because he saw a distant blacksmith swinging a hammer before he heard the clang. Buridan's formulation of Newton's first law was inspired by his observation of a millstone that continued to roll after the gears were disengaged. But neither recorded times or distances. There were exceptions—Theodoric of Fribourg's explanation of the rainbow, Merle's weather data, astronomy in general—but for the most part, the medievals lacked the instruments needed to obtain useful measurements. Measuring distance or weight was simple, but time was problematical and temperature, force, etc. was beyond them. However, their reliance on observation was a large and important step.

Robert Grosseteste has been called the father of the experimental method. He combined the procedures of "resolution and composition" to demonstrate natural laws: First, analyze the components of a phenomenon and *induce* a principle or reason (*propter quid*); then *deduce* the logical consequences of that principle and seek evidence to verify or contradict them. This is recognizably Galileo's "demonstrative regress."

Laying the philosophical foundations for the provability of natural laws was no small thing; but Aristotelians were wary of deliberate experiments. Substances possess inner principles that inform their development "in a manner harmonious with their environment," and the purpose of Science is to understand how those forms work. By imposing artificial conditions, an experiment interferes with the natural environment and hence with understanding the principles. (For example, a genome may express itself differently under different environmental cues.)

Magicians, more interested in practical results than in hidden principles, did conduct experiments, dubbed "natural magic." ("Magic" meant that the inner principles were hidden [occult], not necessarily that they were supernatural.)

But alchemy had no academic standing, and no institutional base. When Pope John XXII called a conference of magicians and natural philosophers to ask whether magic had any foundation, the alchemists answered yes; the scientists no.

While natural philosophers reasoned about motion—often correctly—they did not apply their conclusions to the actual motions of real objects. Buridan explained motion (*L.*, momentum) by an impetus proportional to the "weight and speed" of the body—and even applied it to planetary motions; but he made no calculations for actual millstones or planets. Again, measurement was a problem: impetus theory implied that bodies in motion were heavier than at rest, but *gravitas in decendendo* could not be weighed without interfering with its speed. The alchemist-magicians, on the other hand, developed no significant interest in counting or measuring, or in making occult principles manifest. It was all rule-of-thumb. Experimental science was born of the marriage of philosophy and magic; but in the Middle Ages, they were just engaged in heavy petting.

Reply to Objection 1. Galileo was employing satire, not factual reporting. We have no record of an actual Aristotelian arguing in such a way. By Galileo's day, rhetorical persuasion had replaced syllogistic proof as the object of reason.

Albertus Magnus [*De mineralibus*] had rebutted Galileo four hundred years early, "The aim of natural science is not simply to accept the statements of others, but to investigate the causes that are at work in nature." Adelard of Bath, Anselm of Canterbury, and others wrote likewise, and Grosseteste, Buridan, or Oresme often modified Aristotle or called him wrong on many points. Granted, as Duhem notes, the Italian scholastics of Galileo's day had reacted *against* the Paris school; but we mustn't assume this applies to *medieval* scholasticism.

Scholastics could not refer readers to a source and page for an argument because hand-made books lacked consistent pagination. Rather than repeat an argument at length, they offered a quote. *The reader was expected already to know the rest.* This was as close to footnote, reference, or hyperlink as they could get, but it gives modern readers the impression of an appeal to authority.

Article 4. Whether natural philosophers used mathematics as a privileged tool for disclosing nature.

Objection 1. *It would seem not, because* Aristotle warned against the use of mathematics in physics. (The mathematical features of objects are accidental, not essential, and the behavior of objects is best explained by their essences.) And the medievals followed Aristotle in all things.

Objection 2. *Furthermore*, physics is about changing things while mathematics is about unchanging things. But principles explain the matter only if they are homogeneous with it. Therefore, following Aristotle, medievals did not use mathematics for science.

On the contrary, Robert Grosseteste wrote "nothing can be understood in natural philosophy and empirical investigation without mathematics." By about 1320, says White, "regularity, mathematically predictable relationships, [and] facts quantitatively measurable, were looming larger in man's picture of the universe."

I answer that the medieval Latins pioneered the use of mathematics to *prove propositions* in physics. (This was very different from the calculation of land areas or planetary cycles.) But to do so, they faced an enormous hurdle: most Greek mathematics was unknown to them. The Romans had never translated it, having little interest in math beyond surveying [of conquered land] and accounting [of loot and booty]. "In mathematics," writes Mahoney, "to succeed the Romans was to succeed to nothing

. . ." Beyond Euclid's *Elements,* little was available. Medieval scholars had to learn from scratch—and without teachers. It was all Greek to them.

Consequently, the Latins often violated Greek rules of geometry—"at times quite creatively," says Mahoney. Their purposes were practical, not theoretical: to clarify geometric references in Aristotle and elsewhere, to do the math required by the "exact sciences" (astronomy, statics, perspectiva, music), or to improve measurement instruments and practices. For example, Dominic de Clavasio [*Practica geometria]* wrote, "The ratio of the circumference of any circle to its diameter is a triple sesquiseptimate [ratio], or thereabouts, because there is no definite demonstrated ratio . . . I do not speak demonstratively, but only to teach how to find the area such that no sensible error remains." He knew π was irrational, but 22/7 was "good enough for all practical purposes."

Aquinas had distinguished three degrees of abstraction: The **physics** of material objects is prior to the **mathematics** of ideal objects, and both are prior to and underlie the **metaphysics** of their being. Further, he distinguished qualities from their quantitative extensions, e.g., heat from temperature, raising the "exact sciences" (straddling the physics/mathematics border) to the status of Science. This eventually led to quantitative *physics*, the 14th century's radical break with Aristotle.

During the 14th century, mathematical *thinking* became embedded in natural philosophy. Oresme developed graphical displays of "longitude and latitude" (x and y), and geometrical methods for summing series and integrating linear functions, and analytical geometry stirred in its cradle. His geometrical proof of the Mean Speed Theorem was good enough that Galileo used it unchanged three hundred years later. It symbolized an important milestone: *a proposition in physics was demonstrated by a mathematical analysis.*

The medievals also introduced the *arithmetic of fractions.* Neither the Arabs nor the Latins understood Eudoxus's solution to irrational proportions. So the Latins created a "procedure of denomination" to convert geometric ratios into numerical ratios, and *solved the geometric problem using arithmetic.* Bradwardine devised algorithms for compound fractions to analyze Aristotle's theory of motion. (He found it contradictory.) Oresme developed a theory of commensurability of compound fractions that implicitly involved fractional exponents. (He used it to discredit astrology.)

The *continuum* was the medievals' greatest contribution to mathematical physics. It began, oddly enough, in a theological question about degrees of charity (Peter Lombard's *Sentences,* 17). Does a body participate in a constant form to varying degrees, *or does the form itself vary?* Arguing the latter, Scotus proposed that the addition of distinct similar parts to an existing form created a unified form of greater intensity. Thus, five parts of redness added to three parts of redness created eight parts of redness in exactly the same way that adding weights produced a new, increased weight. This seems obvious to us because we've had seven hundred years to get used to it; but until the "Calculators of Merton" developed this "intension and remission of forms," Aristotelian contraries had been the rule (wet/dry, hot/cold, motion/rest, etc.) Now, "either/or" could be "more-or-less."

If only they could measure them . . . But the Calculators lacked instruments to actually measure color, temperature, et al. So their mathematical treatments remained thought experiments applied to abstract problems. However, "one must conceive of measuring heat and force before one sets about doing it. If the Calculators dreamed and did not act, that does not mean their dreams were irrelevant to the acts of others." [*Stanford Encyclopedia of Philosophy*, on William of Heytesbury]

Reply to Objection 1. Bradwardine and others consciously departed from Aristotle when they realized that natural processes had to be represented by mathematical functions that hold for all values, and are therefore continuous.

Furthermore, to criticize the medievals both for clinging to Aristotle (as here) and for rejecting Aristotle (II.2, Obj. 2) makes it seem that the objection is really to the medievals themselves.

Reply to Objection 2. Mathematics was "about unchanging things" because arithmetic and geometry comprised all of mathematics. But after Bradwardine's compound fractions revealed logical flaws in Aristotle's theory of motion, he defined a new concept: *instantaneous motion*. Heytesbury used intension and remission of forms to develop the limit concept and open and closed sets. This laid conceptual foundations for the infinitesimal calculus, but that was as close as the medievals got to "a mathematics of changeable things."

Article 5. Whether medieval natural philosophers pursued natural philosophy as a research enterprise rather than as a body of knowledge.

Objection 1. *It would seem not, because* the Middle Ages had no sense of the natural world as a thing to be explored. Aristotle had explained everything, so nothing fundamentally new could be found.

On the contrary, John of Salisbury [*Metalogicon*] wrote, "Bernard of Chartres used to say that we are like dwarfs on the shoulders of giants, so that we can see more than they, and things at a greater distance, not by virtue of any sharpness of sight on our part, or any physical distinction, but because we are carried high and raised up by their giant size." And Fra Giordano of Pisa wrote, "Not all the arts have been found; we shall never see an end to finding them." Therefore, the medievals had a sense of research and progress.

I answer that there can be no research enterprise without a defined body of knowledge in the first place. In the Latin West (and Islam), the natural sciences were organized into an Aristotelian schema that, in Peter Dear's words, "determined what was worth saying" about natural philosophy. At first, this meant understanding how particular facts "fit" into this structure; but by the 14th century, it had become clear that Aristotle's *conclusions* were sometimes wrong. Buridan at Paris, Bradwardine at Oxford, and others—working within the framework of Aristotelian *principles* and methods—had begun amending and correcting them. Meanwhile, outside the universities, *engineering* was being pursued using deliberate research.

Reply to Objection 1. Unlike *ingeniators* and magicians, university scholastics were indeed more focused on *understanding* known facts than on *discovering* new facts. Kuhn called this "normal" science (vs. "paradigm-shifting" science.) But if Aristotelian natural philosophy was essentially a taxonomic scheme, the same is true of any of its contradictory successors—positivism, instrumentalism, etc. The sense of revolution that animated 17th century science came partly from "unpacking" the consequences of these new philosophies. There was a sense of "doing something new" that Europe had not felt since . . . "unpacking" Aristotelianism in the 11th and 12th centuries.

That's why Columbus' voyages symbolize the start of the Modern Age. It wasn't the discovery of the New World that mattered. It was "the discovery of discovery."

Article 6. Whether medieval natural philosophers reconstructed the social basis of knowledge around a positive evaluation of cooperative research.

Objection 1. *It would seem other-*

wise, because the positive evaluation of cooperative research begins with The Royal Society and similar bodies.

On the contrary, Stock writes of the Middle Ages that "the same commerce that re-monetized the economy established, for the first time since antiquity, a self-conscious community of intellectuals whose uninhibited communication with each other was the necessary condition for the advancement of learning."

I answer that this new class of university scholars moved with ease from university to university. They adopted the trappings of knighthood, with titles, robes, ceremonies of initiation, and the like. People even called them "the new chivalry." But while they were in correspondence with one another, their work was essentially independent. The *peer review* used in theology to ensure orthodoxy had no counterpart in natural philosophy. Consequently, there was seldom a consensus that a Question had been "solved."

Furthermore, in the "impetus of thought," the *velocity of knowledge* counts for as much as its mass. In the manuscript culture, documents reproduced slowly and accumulated copyist errors. (Two transposed ratios in Jordanus' *Elementa super demonstrationem ponderum* muddled his explanation of the work principle.) Arguably, the greatest medieval invention was the printing press, which replaced one-off manuscripts with *proofread*, mass-produced typescripts, allowing ideas to spread more quickly.

Reply to Objection 1. In 1025, Ragimbold of Cologne and Radolf of Liege engaged in a "mathematical tournament," with other scholars participating as judges. Their letters provide the first example of the simultaneous investigation of a scientific question by different parties in contact with one another. They got it screwed up—Greek geometry was still undigested—but the remarkable thing is that it happened.

Informal groups like the Calculators of Merton prefigured organizations like the Royal Society.

Question IV.
The medieval foundations of the Scientific Revolution.

Article 1. Whether the 17th century revolution could have occurred without the work of the late medieval natural philosophers.

Objection 1. *It would seem it could have*, because the 17th century was revolutionary to the very extent that it rejected medieval categories of thought. The Scientific Revolution occurred *in spite of,* not because of medieval scholasticism.

On the contrary, Duhem says, "the physicists of the Paris school posited the foundations of the mechanics that Galileo, his contemporaries, and his disciples developed." Copernicus repeated arguments made by Buridan and Oresme. Galileo reproduced Oresme's proof of the mean speed theorem and de Soto's law for falling weights using Bradwardine's definition of instantaneous motion. Consequently, writes Grant, "What the medieval scholastics started, their successors in the Age of Reason completed."

I answer that, Duhem's Continuity Thesis disturbed several centuries of assumptions about the Middle Ages. Not until recent times was the medieval era studied with professional dispassion; and if the continuity is not as great as Duhem contended, it is now acknowledged to be much greater than formerly supposed.

But the medieval "pre-discoveries" of modern theories noted by Duhem demonstrate continuity only in "the facts and lore" of the sciences. More crucially, the scholastics accomplished certain preconditions enabling the *methodology* of Science to develop. Following Grant, these preconditions include:

1. The independence of church and state. Charlemagne had modeled his empire on Rome, including imperial control of the priesthood. It took the papacy two centuries to secure the right to appoint bishops, preside over church councils, etc.; but by thus stripping princes of their spiritual roles, the medievals created something new: the secular state. Consequently, in the Middle Ages, *there was always another authority* to appeal to. In the social space between them, independent, freestanding institutions like guilds and universities could grow, which were elsewhere subordinate to emirs or bureaucrats.

2. The cathedral schools maintained Roman learning and passed it on. The Latins were "prepped" well before Aristotle's works were translated.

3. The translations furnished the Latin West with a ready-made curriculum that gave coherence to the study of nature. Had the medieval Church rejected pagan and Islamic learning, or had these translations been of literature and poetry, European history would have been very different—and Science perhaps never born.

4. The universities gave Science, for the first time in history, a home base with freedom of inquiry where the "ready-made curriculum" could be taught.

5. The theologian-natural philosophers. Since natural philosophy was a prerequisite for a theology degree, the theologians were trained in natural philosophy and regarded it favorably.

6. Freedom of inquiry into nature. *Parens scientiarum* and the administrative struggles of the arts faculties at the universities helped establish the principle. The *disputatio* and the Questions genre, which required arguments for both sides of a question, encouraged a "culture of poking into things." William of Ockham declared, "Assertions . . . concerning natural philosophy, which do not pertain to theology, should not be solemnly condemned or forbidden to anyone, since in such matters everyone should be free to say freely whatever he pleases."

7. The maintenance and improvement of the exact sciences. A few examples from the medieval West are: the explanation of the rainbow (Theodoric of Fribourg), the work principle in physics (anon., *Aliud commentum*), motion on an inclined plane (Jordanus de Nemours), image formation on the retina (Witelo), laws of magnetism (Pierre Maricourt), and "Gresham's" law of money (Nicole d'Oresme).

8. The problems of science. The Middle Ages established the subject matter of modern science: the nature of space and time, the existence of a vacuum and the possibility of motion through it, the kinematics and dynamics of local motion, etc. The scholastics posed hundreds of different questions and cited a massive amount of empirical data (bellows, siphons, etc.) Galileo and the others did not work on new questions; they found new answers. As Grant says, "Without the natural philosophy of the universities, the 17th century would have had little to discuss."

9. The language of science. The medievals passed along Aristotelian terms like potential, cause, matter, substance, analogy, relation, quantity and quality, genus and species, and created new terms like numerator and denominator, uniform motion, acceleration, gravity, momentum, impetus, inertia, kinematics and dynamics, intensity and quantity. Without this language, we could not talk about the problems of science.

Dear's "six innovations" of the Scientific Revolution did not pop out of nowhere. Without these medieval preconditions, a tipping point could not have occurred in the 17th century, if indeed ever. As R. R. Palmer wrote in *A History of the Modern World,* "scholastic philosophy laid foundations on which later European thought was to be reared. It habituated Europeans to great exactness, to careful distinctions, even to the splitting of hairs. It called for disciplined thinking. And it made the world safe for reason."

Reply to Objection 1. Etienne Gilson [*La Philosophie au Moyen Age]* wrote, "It is necessary . . . to relegate to the domain of legend the history of a renaissance of thought succeeding to centuries of sleep, obscurity, and error. Modern philosophy did not have to undertake the struggle to establish the rights of reason against the Middle Ages; it was, on the contrary, the Middle Ages that established them for it, and the very manner in which the seventeenth century imagined it was abolishing the work of the preceding centuries did nothing more than continue it." Galileo, Harvey, and even Newton used methods and principles that were recognizably Aristotelian.

Article 2. Whether a Scientific Revolution could have preceded the 17th century.

Objection 1. *It would seem that a scientific revolution could have occurred in the 14th century because* all of the preconditions for the revolution were in place by then, and most of Dear's six transformations had at least started. By the 14th century the medievals had rethought the science of motion and introduced crucial kinematical and dynamical concepts—and the 17th century revolution occurred primarily in the science of motion.

On the contrary, medieval natural philosophy was "holistic." It tried to explain the world *as perceived by human senses*. This was trying to explain too much, too soon. The 17th century succeeded because they restricted themselves to the simple, well-behaved domain of primary qualities, contrived experiments, and efficient causes.

I answer that the 14th century "Paris school" and "Oxford Calculators" did not between them ignite a scientific revolution. But *might* they have done so? Counterfactuals are easily imagined, less easily substantiated. History happened as it did for reasons often centuries in the making, and can seldom be altered by changing whimsically this event or that.

What were the drivers? The medievals were devoted to reason and had separated philosophy from theology. They developed the very concept of natural laws governing a tangible universe accessible to reason. They gave science an independent home base in the universities. They conceived of qualities as measurable, applied mathematical models, and required that philosophical conclusions be "saved by the appearances" of sensory experience. Outside the universities, alchemists conducted experiments; and ingeniators engaged in deliberate research and innovation. A continent-wide network of scholars accustomed to asking probing questions about nature had begun researching non-Aristotelian theories of motion. Letter symbolism was in use, and the arithmetical operators had appeared. Subject/object duality was genuinely lacking—but an Aristotelian alternative to atomism existed that did not require it.

What were the inhibitors? The effort to explain the world as perceived by humans was biting off more than they could chew. (Imagine teaching physics and psychology as a single, combined science!) Their reliance on empiricism did not overcome their suspicion of deliberate experimentation. Their conviction that qualities were measurable awaited instruments to measure them. They applied mathematical *thinking*, but, except in the exact sciences, little mathematical *calculation*. Letter symbolism and operators were still used as shorthand in otherwise verbal discussions. Lastly, the "*velocity of knowledge*" was too slow: ideas didn't circulate fast enough to start a "chain reaction."

But if the abortive 14th century revolution came so close, why did three centuries pass before the successful 17th century version? Three factors suggest themselves. During the Renaissance, Neoplatonic idealism grew at the expense of Aristotelian empiricism, and intellectual emphasis shifted to art and literature. In the Reformation, reasoned theology retreated before personal piety. Like al-Ghazali, Luther dismissed "the whole of Aristotle." Scientifically, these eras marked time. But one additional possibility is that *there simply weren't enough people*.

At the height of the 14th century, the Black Death wiped out a third of Europe. Ockham and Bradwardine were two who perished. Populations did not recover 14th century levels until . . . the 17th century. And if the *velocity* of ideas is as important as the neutrons in an atomic pile, so is the *critical mass* of minds to emit and be excited by them. Only by Galileo's time would there again be as many natural philosophers as in Buridan's day.

Reply to Objection 1. That a "true science" is impossible within Aristotelianism stems from its conscious rejection by 16th/17th century Neoplatonists. Arguably, the Scientific Revolution was more an increased understanding of how to apply mathematics than it was a rejection of the *principles* of Aristotelian physics. The *conclusions* of Aristotelian physics are another matter—many of them were factually wrong. Yet, we do not reject *Galileo's* principles merely because he insisted on circular orbits, claimed comets were atmospheric phenomena, or cited the ocean tides as proof of the earth's rotation. In fact, Aristotle had sound empirical reasons for rejecting heliocentrism [*On physics*]—perhaps even for saying that men had more teeth than women [*On animals*]. By the 14th century, Aristotelian conclusions were being questioned and corrected *within an Aristotelian framework*. Even the conceptual hurdle of deliberate experimentation might have been overcome. The "artful vexation of nature" certainly had important advocates.

The medievals did not draw the objective/subjective line in quite the same way, and their theory of *minima naturalia* was not that of atoms; yet modern "atoms" seem much like "minimae." Heisenberg's uncertainty principle and "spooky action at a distance" have battered 17th century positivism—and resurrected 14th century ghosts. Form and telos have been making a quiet comeback under new names. "The philosophy of nature produced by authors such as Aristotle or Thomas Aquinas is perhaps less out-of-date than expected," writes Tanzella-Nitti.

So the 17th century revolution could not have happened in the 14th century. We may as well wish for the moon—which, come to think of it, is pretty much what kicked things off. But a *14th century* revolution might have occurred in the 14th century, one based on minimae, Thomistic psychology, and all four Aristotelian *aitia*. It would have looked different than the one we got—less revolutionary, more "holistic," lacking Cartesian dualism—but must revolutions come in only one flavor?

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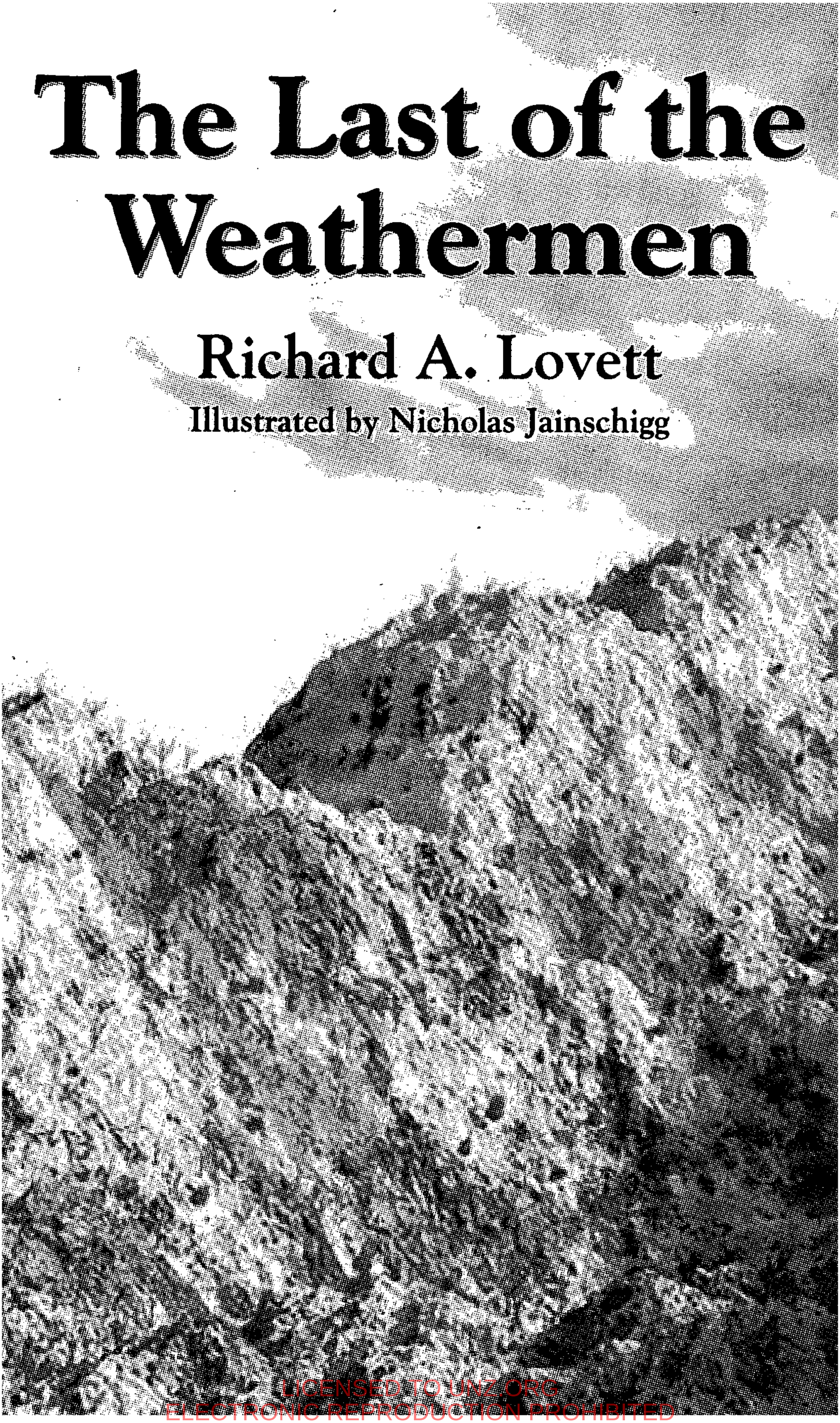
The Last of the Weathermen

Richard A. Lovett

Illustrated by Nicholas Jainschigg



What's the difference between a tool and a drug?

Wind: 15
Temp
PARTLY CLOUDY

That's an impressive watch you're wearing. My grandkids would love the buttons. A sat-uplink? Good ol' Dick Tracy, though I guess he was before your time—mine too, though not by so much that things like that don't make me think of his . . . gads, what did he call it? Two-way something-or-other. The trouble with age is it eats holes in your memory: big blank ones where words used to be. Not that I'm complaining. Much, anyway. "Consider the alternative," my wife used to say, God rest her soul.

Oh, that was three or four years ago, but thanks. You never really get over it, which is probably why I hang out around here. Though I also like the view.

So, what do you use a watch like that for? Market updates? I can see how a young guy like you might like that. No, forty-five's still young. When you get to my age, you'll want nice, safe investments, not things that have to be baby-sat. I'd rather not have to deal with some Euro market crisis at 2:00 A.M. I did enough of that the old-fashioned way.

Can I buy you a drink? Well, okay, but the next one's on me. I'll have a pinot noir; it's still what we do best around here.

I've never had a watch that fancy, but I knew it had to be multi-channel the moment I saw it. I may be a geezer, but I still read the mags. Wrist-radio! That's what Dick Tracy called it. In his time they'd never heard of satellites. No, he wasn't a real person. He was a comic-book hero, way back. But that thing's got to be more than just a sat-com. It's got too many ports, just for up-and-down.

Local telemetry? Ah, so that's a med screamer. I've heard of 'em, but never seen one. What's it monitor? Heart rate, EEG, EKG—wow, when I was your age, it took a hospital to do all that. What's it use for the blood chemistry, a nanoprobe? I don't think I could get used to having one of those stuck in me, even if you really can't feel it.

I'm impressed by how small it is. The early weather-watches were clunkier and all they did other than the normal watch things was download the local 'cast. Even now, I wish the screens were big enough to show a decent map. Professional habit, I guess. I like to see for myself what's coming at me.

Oh, I was a meteorologist. No, that was about weather, not shooting stars. Kind of a dead profession, I suppose. They used to call us weathermen, back in the day. My name's Harvey, and I was pretty much the last of 'em. I miss it sometimes.

Yeah, maybe I should get a screamer, too, but I'm too old to die young. And even without that nanoprobe thing, I don't want to spend my time wired to some gadget that's going to baby-sit me, like you baby-sit your stocks. Tell me, do you know the signs of a heart attack? Yeah, falling down and clutching your chest is one of 'em. That's the one you don't want to wait for. Any others? I thought not. That's the problem with gadgets: they're worse than age at turning your brain to Swiss cheese.

You think that's funny?

Let's grab those window seats over there before someone else gets 'em. The best view's on that side because that's where the weather comes from. Once, I could do as well as the AcuCasts, simply by looking at the sky. See that sunset? Nobody knows what it means anymore, but when it turns red and pretty like that, the rain's clearing out. Otherwise, the light couldn't get through. The clear spot should be over us in a few hours, so if you're into golf, tomorrow should be great. Check it out if you don't believe me.

No, it's not just a cute trick! Understanding the weather helped save my life once, and that's a fact. Let me get us another round, and I'll tell you about it.

It was late October . . . must have been twenty-seven years ago. I'd been working hard all summer, as though trying to see how fast I could work myself out of a job. Actually, I really was in a race: I still get royalties every time you check the 'cast anywhere within a hundred miles of here. Better investment than anything I ever got from those midnight calls to my brokers, though it did wreck my first marriage.

I worked so hard that for about six months I didn't even take a weekend off. I've always been an outdoors type, so that was a big loss. Then, just when I finally finished, we got this great spell of Indian summer, so I picked a mountain range out in Nevada, loaded a pack, and hit the road.

Most folks think there's nothing in Nevada except Vegas and Reno. I hope they never learn. Did you know Nevada has more big mountains than any other state? If you know where to look, you can find aspens and wildflowers and glacial lakes. I was heading for the northeast corner, where there's a whole band of ten-thousand-footers, smack-dab in the middle of nowhere. I'd always wanted to go, but it was too remote, and I'd never found time. That was the year after my first wife left, before Ruth Anne, so I finally had my chance. I went by myself and didn't even tell anyone, which probably seems silly to you, but was heaven to me. And it wasn't the going solo that nearly did me in, I might add.

Even driving in, I remember not liking the look of the sky. In the last two hundred miles, I must have stopped three times to check, but the satemetry hadn't changed. It might have been better if it had. Then I would have known something was wrong, and maybe I'd have started thinking rather than trusting. One of the things that trip did was make me a lot smarter about such things.

On the car computer I had access to the full 'cast, not just the GPS-coordinated things you get on the watches. There were showers in the mountains—that's why I kept stopping—but the computer insisted they would dissipate, except way down south in the Monitor Range, where a couple of models thought enough moisture might blow in from the Carson Sink to produce a few more.

Not long before, I'd have loved that mixed report. It's the type of thing that forces models to evolve, particularly if the minority 'cast is the one that proves right. But I was officially retired. All I really cared about was that I wasn't going to the Monitors.

Where I was going, the predictions were consistent. The consensus, based on a reliability-weighted Bayesian assessment of something like thirty-nine models, was that by sunset, 10 P.M. at the latest, the showers would be gone and we'd be back in Indian summer.

It's odd how the memory-holes eat some things but leave others. Why should I be able to recite something like that when the names of old friends vanish? These days, of course, the 'casts don't bother to tell you that type of technical stuff because it's only geezers like me who have a prayer of knowing what it means. Hell, by now the models have probably evolved so far that nobody knows how they work. Even back then, the Nevada ones must have been self-correcting for years. Inland 'casts are a lot simpler than those I'd been working on, this close to the coast.

With all those stops, the drive took longer than expected, and when I got to the trailhead I either had to start hiking right away or camp and sit it out overnight. I had a three-day loop planned, and while I was in pretty good shape for a fifty-five-year-old, I really wanted to knock off a few miles that evening. So a few minutes later, there I was, walking up a canyon with the sky growling overhead and raindrops slicking the rock.

I remember thinking that when I was in school, "showers" and "thunderstorms" weren't the same thing. But there wasn't much time to fret. At that time of year, it gets dark early. You've got to decide what you're going to do and do it, or you wind up trying to find a camping spot by flashlight, which is no fun. Believe me, I've had to do it a few times. This time, the main risk was that I'd wind up stuck in the middle of the washed-out jeep track my hiking guide called a troad.

No, that's not a real word. It's an amalgam of "trail" and "road." A bit too cute for my taste. But whatever you wanted to call it, it was nothing but rocks the size of pie pans. It was hard enough to walk on. Camping would have been miserable.

I had a few bad moments when lightning started stabbing at the ridgelines on both sides of me. For a couple of miles I really did toy with giving up: going home and coming back next year. But I was thousands of feet below the summits, safe from being fried. And you never know, as you get older, when arthritis or bursitis or some other -itis you've never heard of might steal the backcountry from you forever. So, although I figured this was going to be a learning experience for the Northern Nevada models as well as those down in the Monitors, I kept walking.

Meanwhile, I was noticing that the canyon didn't have the junipers, sagebrush, and limber pine you usually find at those elevations. Instead, there were honest-to-goodness spruce and fir. That meant it was unusually wet, so if it was going to rain anywhere, it would be here—though the models should have taken that into consideration.

I suppose I should tell you a bit about modeling. Today's 'casts are about 99.99 percent accurate, but when I was in grad school, forecasting was half art, half science. It might surprise you, but the first good models were for long-range 'casts—in the range between two days and the time chaos theory says no model will ever work. With shorter-range predictions, the human advantage lay in intuition and understanding local conditions. It was something like me telling you tomorrow's weather, but subtler. The farther out you go, the more data you need, until, with the long-run stuff, you've got nothing *but* the models, so of course the computer's going to beat you. No problem, most of my colleagues figured. Short-range 'casts would keep us in business. But I got to thinking and realized it was just a matter of time: the only way to stay employed long enough to earn a pension was to help write the models that put everyone else out of business. Royalties were something I only thought of later.

Luckily, that night in Nevada the rain never amounted to much and about four miles in, just as it was getting seriously dark, I found a nice little campsite, right by a creek.

The downside of October camping is that I was facing thirteen hours in an itsy, one-person tent. I tried to drag out dinner as long as possible, but by seven o'clock, I had to concede the evening to the cold. That was in the days before anyone had made a weather-watch smaller than a deck of cards, so I had a palm unit instead. I tried to check for updates, but my snug little campsite was too deep in the creek's ravine for the palm-gadget's low-power GPS unit, and without a GPS fix the palm was worthless—just like today's watches. I've always wished they'd just let you key your own coordinates into those things, but I've never seen one that allowed it. Most likely, the lawyers are afraid you'll push the wrong button and get the 'cast for Australia or something, then sue 'cause it ruined your picnic. It's the same mindset that puts all those safety devices on your car to protect the kids you no longer have, then makes it illegal to turn 'em off. Still, when I crawled into my tent, I was starting to see stars, so it looked like the 'cast had been wrong only about the lightning.

That night, there was moonlight on my tent, so it must have been mostly clear. Morning was a different matter, with thin clouds that *looked* cold. On the oh-oh scale of things you don't want to see in the mountains, that's about a seven, because they mean there's weather around that at least wants to be a storm. So, after a quick breakfast, I took the palm unit and a cup of coffee and wandered around until I finally found a spot where the GPS could get a fix.

The 'cast hadn't changed, but even then I don't think I believed it. The same open spot that allowed the GPS to do its thing allowed me to see the ridgecrest, where the highest summits were playing peek-a-boo with clouds shaped like sideways teardrops. Technically, they're called lenticular clouds, and if you're one of the few people who pays attention to this stuff anymore, they raise the oh-oh scale to at least a nine. Worse, they mean wind. Lots of it.

I never did find out what was wrong with the 'cast. Perhaps I'd just gone so remote that nobody had bothered to tell the model about the spruce and fir and whatever produced enough rain for them to be there. But I'd also forgotten just how local a local 'cast can be. Thanks to the GPS, I was getting a prediction for "down here" when what I wanted was one for "up there," and while "here" and "there" were only a couple of miles apart, mountains make their own weather.

At least I wasn't a total idiot. The moment I saw the clouds, I gave up my planned loop. It involved crossing the ridge, and there was no way I was putting it between me and my way out. But the 'cast still lulled me into figuring I had time for a day-trip. Just to be on the safe side, though, I decided to lug my whole pack up the hill. My main concern was not to be too far from my survival gear if I twisted an ankle, but it proved to be the first truly smart thing I did on the entire trip.

My destination was a lake, a couple hundred feet below the pass. With the pack, the trail was steep as hell, and as I climbed, the lenticular clouds got denser and lower. The ground was frozen solid, and the sky looked like Minnesota in January. Anything that fell from it was going to be white.

The lake was a tiny tarn, surrounded by firs. A pretty spot if the weather had been appropriate for basking in the sun. More Minnesota, under present conditions. I dropped my pack and sat on it for a few minutes, then, already cold, scooted up to the ridgeline for a quick look at the other side. If there's a single, irresistible urge for hikers, looking over the top has got to be it.

As I crested the pass, the wind hit with the type of blast that sucks the air out of your lungs. You can tell wind speed by the way you have to stand in it. Thirty miles an hour just feels unpleasant. At fifty, the word you'll use is "buffeted." This was the type of thing that makes you lean forward just to stay put. It caught me by surprise and damn near knocked me over backward. I don't think I even looked at whatever was on the other side. *Okay*, I thought, *that wasn't worth it*. I was just starting to turn back when I heard the voice.

There was a trail junction at the pass. One fork headed on down the other side—the next leg of the loop I'd originally planned. The other stayed high, and the voice was coming from somewhere up there. Not far up, or I'd never have heard it.

I waited a moment for it to repeat, but it didn't. I wasn't really sure I'd heard anything at all, but I had to find out.

I was using a walking stick, or I'm not sure I could have stayed on my feet for the first few yards. Then the trail moved away from the crest and I no longer had to lean at such an absurd angle.

I found her within a hundred yards, which is good because I'm not sure how much farther I'd have gone. She was young—maybe twenty-one or twenty-two, though once you get over fifty, they all look like kids—with long, blonde hair curling around her face. She had no pack and was wearing a cotton sweatshirt and sweatpants, with "Cougar" emblazoned across her chest. She was sitting in the lee of a tree, hunched forward, whimpering, and at first I wasn't even sure she realized I was there. Then she looked at me with these big eyes and I knew there was still at least some intelligence behind them. But she didn't seem all that with-it, because all she said was something that sounded like "ick," which seemed like a huge understatement. Though with the wind roaring in the trees, it could have been anything.

Getting her to her feet was difficult, and when she hit that wind she nearly rebelled. But all of my gear was down by the lake and I figured it was better to get her down to it, more or less out of the wind, than to bring it up to her. I gave her my windbreaker, then found that seconds later, I was shivering. She herself was trembling like a leaf—which is a lot better than not shivering at all.

I coaxed, cajoled, yelled, and eventually got her, first, into the wind, then at long last, out of the worst of it and down the trail toward the lake. At the first semi-flat spot, I left her leaning against another tree, ran for my pack and dashed back up—to the extent you can dash at that elevation. Even in that short time, she'd quit shivering.

I don't think I've ever pitched a tent faster: two minutes, tops. I maneuvered her inside, then grabbed my sleeping bag. I was about to stuff her into it when I realized that somehow, possibly from being up in the fog, possibly by panicking and working up a sweat, she'd gotten all of that cotton damp. So I made her strip as far as she'd go—don't look at me that way: wet cotton is useless, and besides, I couldn't afford to have her bring all of that moisture into our only sleeping bag.

Then I kind of swaddled her in all the spare clothing I had—she was way past being able to put her arms and legs into the right holes—and zipped her into the bag. All told it took a damn sight longer than pitching the tent. Then I fired up the stove and poured about three cups of warm tea into her and, when she wouldn't drink any more, filled a couple of water bottles with hot water and slid them into the bag next to her.

I'd never saved anyone's life before, and you know, it's only gratifying after the fact. At the time, it's scary—and frustrating because you want to be two people, especially if you're trying to get an uncoordinated person into clothes about six sizes too large for her.

Ten or fifteen minutes went by in which the weather got steadily worse and I wondered whether I'd done the right things quickly enough. Then I realized there was something else I could do, so I climbed in the sleeping bag with her. You'd laughed earlier, but my own I'm-not-going-to-be-a-dirty-old-man-phobia nearly deprived her of a source of warmth a lot better than a couple of water bottles.

Meanwhile, I was beginning to wonder how she'd gotten up here, and the answers didn't look good. There'd been no other cars in the parking lot when I'd started, and there was no way she could have hiked past my camp, afterward, without my hearing. That meant she'd come from the opposite direction, and that was a long way away. And there weren't many twenty-one-year-old girls who'd backpack alone, even if it wasn't October.

When she finally went from not shivering back to shivering and then to only intermittent shivering, I slipped out of the sleeping bag and out of the tent. Maybe she'd camped near here and was trying to get back when I found her. Maybe her friends would be there, safe and sound. Unlikely, but I might also find some spare clothing and an extra sleeping bag. But there weren't many campable spots near the lake, and all were vacant. So much for that idea.

When I got back, I checked the pockets of her sweatpants, but there was nothing but a granola wrapper and a weather-palm much like mine. Too bad she'd not been more skeptical of what she'd read on the palm. Out of curiosity, I powered it up, queried a new 'cast, and found it was still fixed on partly cloudy, which I suppose was accurate because I could see breaks over the low country, a few miles away. Up here, though, we were definitely in the wrong part.

Back in the tent, I found that she was shivering less, though I wasn't sure she fully understood where she was. Still, when the draft hit her, her eyes fluttered, then focused on me.

"Ick," she said again.

I shook my head, trying not to kneel on her as I zipped the tent shut behind me. It really was extremely tiny.

She tried again, and this time I realized it was a name. Mick. Or maybe Nick. At the time, I couldn't tell. "Ju fine dim?"

It was a struggle to understand her, but eventually, I learned that she and her boyfriend—definitely Mick—had camped at another lake called Emerald. Or maybe it was Topaz, or Ruby. Some jewel. I knew it then, but forget now.

The lake was a couple of miles up the ridge, and they'd tried to hike down here, expecting the clouds to break as the forecast implied. Instead, it had been unbelievably cold, and they'd turned back. Mick was in a hurry, and some of the things he'd said hadn't made a lot of sense. She'd struggled to keep up—that's when she got sweaty—then she got colder and slower, and he'd disappeared into the fog. After a while she'd realized she was never going to get back up to their camp and that her only hope was to go down, even though she didn't know where the trail went. Then she'd gotten so, so tired and cold, and she'd sat down to rest a bit and wasn't sure how long she'd been there when I came along.

I may be male, but there are times when I'm a traitor to my gender. I don't know what it is about guys that makes their reasoning so much more vulnerable to hypothermia, but I'd encountered this once before, up in the Washington Cascades when a group of us found a woman abandoned by her husband. She wasn't in anywhere nearly as bad shape and we had lots of extra clothing, but when we got her to the trailhead, the damn husband had taken the car and gone home. Maybe it's a body-fat thing. Women get cold easier, but they have that extra layer that may help them last longer. Maybe I should be more sympathetic, but I always hoped that she went home and divorced the jerk.

Still, my job was simple. I'm not brave, but there are times when there are things you must do. Maybe Mick was back in camp, warm and dry. More likely, he was in trouble and I had to find him. If I could.

I took back as much of my clothing as I could, and headed off, up the ridge. I had my pack, but I didn't have as much in it as I'd have liked because the girl was using the most important items: the tent and sleeping bag.

The wind was worse than ever, and within minutes the visibility had clamped down to almost nothing. What little I could see was damp, gray, and going sideways, fast. According to the map, it was only a mile and a half to the other lake. In good conditions: forty minutes. Now, it must have taken twice that. Every few paces, I'd stop to shout, though it seemed hopeless. If Mick hadn't gotten back to his tent, he'd probably collapsed. If he'd wandered off the trail, I'd never find him unless he had the energy to answer my calls.

The lake came upon me by surprise. One moment, I was plodding along. The next, I was staring at gray water. Definitely not emerald. Or azure. Or whatever. It wasn't very big; even in the fog I could see tree-shapes on the far side. Shouting loudly enough that it hurt my throat, I started combing the area for a campsite. A couple of minutes later, I found it—or more precisely, heard it.

The tent was a cheap discount-store model, snagged in a clump of bushes where it snapped in the wind like a flag in a gale. Its poles were smashed and there was nothing inside, but downwind I found a sleeping bag, impaled on a branch, leaking the last of its feathers. The other bag was nowhere to be seen, though I wasted several minutes looking.

Upwind from the tent, I found where it must have been pitched. Some of the stakes were still in place, plus a backpack, stove, and a few other items too heavy to blow away. Only one pack, and rifling through it revealed the wrong type of clothes for Mick. Mostly cotton, mostly damp, mostly useless.

I was colder than I'd ever been in my life, but I forced myself to think. Mick had come back here and picked up his pack. Maybe good, maybe not. If he was as poorly equipped as his girlfriend, there wouldn't be much of value in it, and he'd left the stove, which actually would have been useful. I forgave him a bit for leaving the girl. His judgment was obviously shot. What he should have done was retrieve what was left of the tent, find a big rock or other windbreak, use the stove fuel to light a fire, and hunker down. Instead, he was trying to walk out.

Opening the map without having the wind rip it away was difficult, but eventually I learned that there were two ways to the trailhead where the girl had told me they'd started. One dropped into a valley that should be reasonably sheltered, but was long and roundabout. The other stayed high most of the way. If it were me, I'd have taken the long way, but most people would probably try the short one.

I wanted nothing more than to turn back, but that wasn't an option I could live with. I'd brought my own stove, so I left Mick's where it was and went back to walking, faster than before because I wasn't bothering to shout since there was now so much wind I'd never hear him unless he was close enough that I'd see him, anyway.

In a half-mile, I found the sleeping bag: a damp mess in a poorly waterproofed stuff sack, dropped, most likely, in an effort to lighten the load. I left it: wet down is worse than wet cotton and takes forever to dry. Thirty minutes later, I found the pack.

Then, it started to snow: tiny, deadly flakes, hard-driven before the wind. I was getting pretty cold and my own judgment wasn't what it could have been, so I hurried on until suddenly I realized that the snow was starting to pile up. Not deeply, but inexorably.

That's where my weather knowledge saved me. I didn't care what the 'cast said. If there was one thing I was sure of about conditions like this, it was that once it started to snow, it wouldn't be a mere flurry.

A few hours earlier, I'd saved a life. Now, I gave up on one. It was hard, because I kept hoping to find him around the next bend. But realistically, if I did, there wasn't much I could do. And the moment the snow piled up deeply enough that I couldn't follow the trail, we were both dead, whether I found him or not.

As it was, I nearly waited too long. The snow was worse than the fog: a swirling nightmare in white, and the trail, typically Nevadan, was faint at best. Now, it was disappearing with amazing speed.

There's all kinds of equipment today that would have made that hike more bearable. Some existed back then: thermal boots with pull-tabs that release a slow, chemical heat. Battery-warmed gloves. Etc., etc. A simple web-linked satphone would have been nice. Hell, your screamer would probably have been yelling for help, already.

But I never take phones into the wilderness because you wind up trying to work. Or you spend all your time checking the stock market or your satmail. That's why I liked the weatherpalm. It gave me what I wanted, and spared the rest. Of course, right then, I'd have gladly used all the tech I could get.

Though I'm not sure how much good calling for help would have done, because it would have taken a long time for anyone to get there. Maybe that's another reason not to rely too much on such things.

Instead, I trudged, staggered, and tried not to think of Mick. When I got back to his campsite, I wasn't in much better shape than he must have been when he left it, because I never even thought of holing up and building a fire or of rifling the girl's pack for the few useful items it might have contained. I was totally fixated on getting back to my tent, and wishing I'd not left *any* of my clothing with her. By the end, I was counting paces. Fifty steps, and then I could turn my back to the wind and count to fifty. Fifty/fifty. Probably about my odds of actually making it because the trail really was disappearing and I was in the fog the whole way. *Partly cloudy*, my ass. That means you're under the cloud, not in it.

Earlier, I'd helped the girl. This time, it was her turn to help me. Maybe it *was* a good thing I'd left the clothing with her. She found me about where I'd found her, and while she was too petite to half-carry me the way I'd half-carried her, she could at least take the pack. I later learned that every few minutes she'd hiked up as far as she dared, then gone back to the tent to warm up. It must have taken unbelievable guts, but it sure made my last few minutes easier, because she'd tromped out a nice, easy-to-follow path, even though the snow was starting to fall pretty heavily by then. I suppose that if you die in the wilderness the details hardly matter, but somehow it would have been worse if it was by losing my way that close to shelter. I'd really hate for my last thought to be *how ironic*.

Back at the tent, we again shared the sleeping bag, this time with the roles reversed. She didn't say much at first, and neither did I because there wasn't much to say. I'd tried, and failed. Not the stuff of heroes. I hadn't decided whether to let her know that if Mick had been just a little wiser, he might have saved himself.

While I'd been gone, she'd folded her wet sweats and tidied up what little I'd left in the tent: make-work, most likely. Now she reached into a ditty bag and pulled out her palm. "Stupid thing," she said. "Mick loved gadgets."

I thought of the pull-tab boots I'd wished for, but it obviously wasn't the time to tell her that gadgets sometimes have their place. It's a matter of keeping your brain engaged—and I'd nearly failed that one myself. Though if I'd been smarter, I'd be back at my car and she'd be dead. Irony can work both ways.

A couple of minutes later, she spoke again. "Is it wrong?" she asked, and at first I thought she was still thinking about the 'cast. But she was off somewhere deeper. "I should have been worried about Mick," she said, "and at first I was. Then, all I could think was that if you didn't come back, I had no idea how to get out of here." Then she added, so quietly it was hard to hear over the storm, "Mick and I had only been together a couple of months." And, even more quietly: "Why did he leave me?"

What do you say to something like that? I was warming up enough that I could find her hand and give it a not-utterly-uncoordinated squeeze. Enough that my half-warmed fingers hurt like hell when she squeezed back, hard. Enough to tell her how hypothermia makes you stupid long before it makes you unable to act on that stupidity. Maybe Mick thought he was going for help. Maybe he'd lost track of whether she was behind or ahead. Most likely he'd just panicked, but my own brain was functioning well enough not to see any percentage in telling her that. Nor did I tell her that if he'd not left her, they might both be up on that ridge somewhere.

As for the is-it-wrong question, I had

no answer to that. I thought of her, with nothing but wet cotton and a few borrowed clothes. With a tent and sleeping bag but no way to carry them. Without a map. I'd been so busy, first trying to find Mick, then trying to save myself, that it had never crossed my mind that if I died, she probably would too. It made me feel a bit better about giving up on Mick.

Let me tell you something: two people in a sleeping bag makes for one long night. Especially if someone has to get up every couple hours to knock snow off the tent. Then you're both cold for a while, afterward. Despite what you think, it's just not sexy, especially when you're trying not to worry about what's going to happen tomorrow. The moment there was enough light to see my hand in front of my face, I was out of there, digging my pack out of the snow and checking the weather: by eye, not by palm, because I'd checked that a dozen times already and it was still saying partly cloudy, though it was now talking about a high temp of 17°.

For once, partly cloudy was right. The lenticulae were gone, leaving in their wake puffs of white against a background that would gradually lighten to a flawless eggshell. It was like being mocked by a perfect Christmas card when you don't feel anything like Christmas. The snow was shin deep, except in drifts, where it was a lot deeper.

The girl was in as much hurry to get out of the tent as I was, and a moment later, she was standing beside me, arms wrapped across her chest, hands under her armpits. That's when I realized just how miserable the day was going to be. I only had one set of gloves.

She didn't say anything, and I didn't either. Not about gloves. Not about the scenery. Particularly not about Mick. We'd talked quite a bit after some of those knock-the-snow-off-tent sessions, though not again about anything deep: it was too soon for that. Her name was Sanda—no, not Sandra. I don't know why. Why is anyone named anything? She was a recent college grad, with a major in something fun but economically useless, like history, trying to figure out what to do with the rest of her life. I later learned that Mick was similar, only he'd not had time to learn the answer.

Hiking out was awful. I can't tell you the number of times I wished I had another pair of gloves. Or a pair of those pull-tab boots, though I'd have pulled the tabs the day before and used up the magic chemicals, so that was a silly wish. Luckily, neither of us frostbit anything, though the first few hours were nip-and-tuck. The good thing was that we were going down and the route was dead simple: follow the creek until you reached the car. Impossible to get lost, if you knew basically where you were going.

What we *could* do was lose the trail, and we did a lot of that, thrashing through brush, slipping down steep slopes, and stumbling over buried rocks. We also did a lot of just plain getting cold, though nothing as bad as the day before. Before leaving, I built a fire and did my best to dry out her cotton sweats—though I was in a hurry, so "singed" might be a better word. Then I made her wear my rain pants and parka, so she'd not get wet all over again. It wasn't great, but it kept us both alive.

By mid-afternoon, we were down to my first campsite, by the creek. It was a lot warmer down there, but it was also starting to thaw, so the warmth was a mixed blessing because she got wet again, despite the pants and parka. I had to pitch the tent and put her in the sleeping bag while I found about forty ways not to build a fire in wet snow, but eventually I succeeded by drowning a bunch of twigs in stove fuel. By the time her sweats were dry again, it was getting late, but neither of us wanted another night in the tent, even if the palm and I agreed that there wasn't much risk of more snow. Besides, the rest of the way was easy because we were back on the troad and there was only six inches of snow. By the time we got to my car, just about dusk, there were only three.

So that's the story. Mick didn't make it. A couple years later some hunters found his body about two miles beyond where I'd turned back. I came awfully close to being up there with him. And, in case you're wondering, there's nobody to sue if the 'cast is wrong. It's one of those weird areas of the law: you can sue for a badly designed watch, but not for an inaccurate forecast. Someone tried that once, and the court pulled out an old rule protecting weathermen like me. It also decided that self-correcting computer models are "autonomous entities" for which nobody is responsible. I'm sure the same rule would apply if your screamer screwed up.

Who says it can't screw up? What if the battery dies? I don't care if it uses piezoelectric whatevers to recharge from your arm movements. That just means there's some mechanism in there that can break. You might at least think about learning the symptoms of a heart attack. Or a stroke.

I can tell you're not convinced. Sanda's now an emergency-services planner down in Phoenix, and she complains that half her EMTs don't bother to learn things like that, either, because they're sure they can always get them by uplink.

Yes, we've kept in touch. I knew you'd ask. That's the cool part of the story, though not in the way you're thinking. As soon as we got to the trailhead, I used the car computer to call the cops, then let Sanda call her family. The closest was an aunt, up in Idaho. Turned out her name was Ruth Anne. Not all ironies are bad.

So, think about what I was saying. I don't usually tell this story to strangers, but maybe this is another of those ironies. Way back, you thought I was joking. But maybe I just saved your life. ■

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A Time for Lawsuits

Amy Bechtel

It's hard to figure out patterns from very small samples. . . .

On Wednesday I made my weekly trip to the dump.

I had a much bigger load than usual, so I'd hitched the two-wheel flatbed trailer to my truck. This was the busy time of year for my veterinary clinic: springtime, which was calving season. Although I was seeing more and more small animals every year, I still loved my large-animal work best, and in spite of the hideous hours involved, calving season was my favorite time of year. I never got over the sheer delight of delivering a newborn calf and then watching it stagger to its feet for the very first time.

Of course there was a downside to the season, as evidenced by the load of dead calves and calf parts on my trailer. Some of my clients hadn't called me until things had already turned disastrous, and I had delivered several dead calves and done several fetotomies this week, neither of which had been at all enjoyable. Cutting up a dead calf inside the cow's uterus, and delivering it in pieces, is always a particularly gruesome procedure.

I swung around a corner onto the main street of town, mentally planning out the rest of my day. If I was quick at the dump, I'd have a few minutes left to eat lunch before the afternoon appointments began to arrive. Perhaps I'd get out of work on time this evening, and I could ask my assistant, Tegan, out for a proper sit-down restaurant dinner.

Someone was honking a horn, over and over again, and I lost all track of my plans. I looked around, wondering what all the commotion was about. A green car in the opposite lane swerved all the way to the curb while the driver waved a hand frantically in my direction. What the hell was going on? I looked out the left window and saw the trailer.

It was *my* trailer, the two-wheel flatbed loaded with dead calves, cruising serenely past me. I watched it in fascination. I had obviously not fastened the hitch properly, but by God I had balanced the load well. Even with only two wheels the trailer cruised along at a good clip, coming closer and closer to Donald Miller's new truck lot. I wanted to close my eyes, but I couldn't look away. The road sloped downhill just before the truck lot, and the trailer picked up an astonishing amount of speed before it passed cleanly between two parked cars, leaped the curb, and crashed into a brand-new red pickup. The contents of the trailer, conserving their momentum, flew off the flatbed and splattered over several more new trucks. For a few moments the sounds of rending metal and thudding bodies echoed in my ears.

Now I closed my eyes. Perhaps if I casually drove off, as if I had had nothing to do with this, no one would notice. "Calves?" I could say, if anyone happened to ask. "What calves?" Of course it would be hard to explain why the incriminating trailer was imprinted with the words DESERT SPRINGS ANIMAL HOSPITAL, MICHAEL CLAYTON DVM.

As the sounds died away, I slowly opened my eyes again. People were emerging from the truck lot's salesroom, milling about like ants from a disturbed hill. I recognized Donald Miller himself, clad in an expensive-looking business suit with a stiff collar and tie. He looked in disbelief at the wreckage of his lot, and then purposefully began to stride toward me.

I finally made it back to the clinic two hours later, only to find the waiting room crammed with irritated clients who had been kept waiting for much too long. Without stopping to breathe I grabbed the top file, opened it, and read the presenting complaint.

Dying, my receptionist Kami had written.

Oh, wonderful. Here I was, hours late to attend a dying pet. Hastily I scanned the chart. The owner's name was Mrs. Collins; the dog, a three-year-old Great Dane, had the fanciful name of Althea. I steeled myself and called them into the exam room, hastily shutting the door on the waiting room full of angry glowering faces.

Althea bounded up to me, dragging Mrs. Collins by the leash, and leaped up to put her paws on my shoulders and lick my face. Mrs. Collins' tugs on the leash were unproductive, but I finally managed to get Althea off my neck and onto all fours. She panted up at me, her eager tail pounding her owner's legs.

She didn't exactly look like she was dying. Apparently Kami had gotten a couple of the files mixed up—she was not the brightest receptionist in the world, and such things had happened before. I wondered which of the remaining patients really was dying, and how I could ensure that I would see that one next.

I cleared my throat and said, "So, Mrs. Collins, what is the problem with Althea?"

I was startled to see her burst into tears. "She's dying, Dr. Clayton. She's dying."

I glanced back at Althea, who was now sitting at her owner's feet. I had not often seen a healthier dog. Puzzled, I gave her a quick examination, and found everything to be utterly normal. Althea licked my face several more times before I escaped to the other side of the room.

"Can you help her?" Mrs. Collins looked at me mournfully. "Please tell me you can help her."

"Well, you see, I'm not quite clear on what the problem is. Her physical exam is quite normal. What have you seen happening that makes you think she's ill?"

"She's not just ill. She's *dying.*"

"But—what makes you think she's dying?"

Mrs. Collins stared at me. "I read about it," she said, "in a book on Great Danes. I can't believe you don't know about it."

Just what had she been reading about? There were certainly many diseases and syndromes specific to the giant breeds, but Althea wasn't showing signs of anything at all.

"Seven or eight years old, the book

said," Mrs. Collins went on. "Great Danes only live to be *seven or eight years old.*"

"Well yes, that's often true with the giant breeds," I said cautiously. "Compared to other dogs, they do have shorter life spans, although I've seen cases in which—"

"Althea is *three,* doctor. She only has four years left. You've got to cure her."

I stood there helplessly, looking from Mrs. Collins to Althea. I certainly could not cure Althea of being a Great Dane. I picked up a box of tissues, led Mrs. Collins to a chair, and sat beside her. I must have spent a good twenty minutes explaining why I could do nothing to help Althea, but it was hard to tell if I ever got through to her. "Dogs simply don't live as long as we do," I said. "And the giant breeds have even shorter lives. But look at Althea. She's enjoying her life to the fullest, and you should do the same. Don't worry about what may happen in the future. Enjoy being with your dog today."

When Mrs. Collins finally exited the room, I recoiled at the even more hostile glares from the waiting room. Sweating, I hurried out to get the next file from the alarmingly tall stack that was waiting for me. It was easier said than done, this business of not worrying about the future. I was already stressing over every single one of the impatient clients in the clinic.

As I picked up the next file, my assistant Tegan whispered, "Did you *really* splatter calf parts all over Donald Miller's truck lot?"

"Yes." I sighed and opened the next file. The owner was Mrs. Gallegos; her dog, Fluffy, was a nineteen-year-old toy poodle with heart disease. I'd seen her regularly over the last few years, and Fluffy had been doing well on medications. But now the present complaint was entered not as a recheck or a medication refill, but as *dying*.

"Isn't Donald Miller the one who brought that dying cat in last month?" Tegan went on. "The one with pyothorax?"

"Yes." I remembered the incident vividly. Mr. Miller had brought in an emaciated cat in severe respiratory distress that had obviously been critically ill for some time. It had died on the table while I was examining it, and Mr. Miller had accused me of murdering his pet. It hadn't been a happy experience.

"Oh my," Tegan said. "This *will* be interesting." She was trying to look sympathetic, but her eyes were bright with mirth. In spite of everything this cheered me, because Tegan had been sunk in gloom ever since she had returned from a recent leave of absence. It was good to see her smile.

I called Mrs. Gallegos and Fluffy into the exam room. Mrs. Gallegos held the little poodle close while I listened to Fluffy's heart and lungs. Fluffy's longstanding heart murmur had worsened, and there was increased fluid in her lungs. My pleasure with Tegan's mood evaporated. This time, Kami had been right.

I pulled the stethoscope away from my ears and stroked Fluffy's head. "Well, Mrs. Gallegos, she is getting worse."

"Then does she need a stronger medication, doctor?"

I looked back at the chart, assessing the treatment she was already on. If I increased the dose of theophylline, there might possibly be some improvement, but there wasn't much else I could do.

"Yes, we can increase the dose and she might feel a bit better, but you've got to realize, Fluffy doesn't have much time left. She's nineteen years old, after all. She can't go on forever."

I remembered, all too clearly, the day I had diagnosed Fluffy's heart condition. Mrs. Gallegos had stared at me blankly for a time, and had then said, "You have to save her, Dr. Clayton. She can't die. She's all the love I have in the world." I had glanced involuntarily at her gold wedding band, and she'd said, "Yes, I'm married. But Fluffy's all the love I have in the world."

I had not known what to say then, and I didn't know what to say now. I could have made some fumbling comment about *marriage counseling* or *perhaps a new puppy,* but these phrases seemed utterly inadequate in the face of what Mrs. Gallegos was about to lose. I did finally suggest grief counseling, but she only looked at me silently, and held Fluffy tighter. I was twitching by the time I sent Fluffy and her mistress home, and when I picked up the next file and saw that the presenting complaint was *dying,* I nearly screamed.

By the time I had seen all the afternoon appointments it was almost nine o'clock at night. I had seen two more pets that really were dying, and euthanized one of them, and all I wanted to do was go home and collapse. But even as I headed for the front door, to finally lock it for the night, Ernest Davenport's battered old car pulled into the parking lot. The driver's door flew open and Ernest scrambled out of the car, clutching a small dog in his arms.

Ernest Davenport was one of my more peculiar clients. He lived somewhere out in the desert, where he was frequently visited by aliens and giant talking birds, and he kept a herd of dogs, all of which seemed to be dachshund crosses of one sort or another. The dogs ran wild, coming into contact regularly with rattlesnakes, cacti, and coyotes, but their numbers never diminished as there were always new puppies being born. And Ernest Davenport was absolutely, totally devoted to each and every dog.

"Oh, Dr. Clayton! I'm so glad you're still here! It's Judy; she's been snake bit."

He put the little dog on the exam table, where she lay utterly still. Judy had very short legs and a wiry brown coat, and her face was enormously swollen. A pair of classic fang marks on her nose oozed bloody serum, confirming Ernest's diagnosis. I had to struggle to find a heartbeat, which was faint and very, very slow.

"Can you save her, doc?" Ernest whispered.

"I don't know," I said. "I'm afraid she's very far gone. I can try to treat her, but she'll probably still die, and you know how much the antivenin costs."

"Oh, you must try," he said. "Cost is no object."

With many of my clients this phrase means, "Cost is no object because I don't plan to pay you anyway," but Ernest always paid. His car was ancient, his clothes were shabby, and he was very far past retirement age, but he always paid his vet bill.

"When did this happen?" I asked, as I hunted for the cephalic vein. Dachshund crosses don't tend to have good veins at any time, and Judy's were terrible.

"I don't know," Ernest said, hanging his head. "Oh, why didn't I go home earlier? I was away all day, looking for aliens, and when I got home I found her like this. She could have been lying there for *hours."*

I clipped the fur on Judy's leg, doused the site with alcohol, and tightened the tourniquet. Was that faint blue shadow a vein? Tegan came in with the antivenin, and I motioned her to hold the dog's leg at a better angle. Miraculously the catheter slipped into the miniscule vein, and I quickly taped it in place. Tegan handed me the antivenin, mixed and ready to administer, and Kami entered the room with Ernest's thick file in her hand.

"Mr. Davenport?" she said. "We don't have a file on Judy, so I need some information. How old is she?"

"Well let me think," Ernest said, watching as I slowly injected the antivenin. "Her great-grandmother was Sapphire. You remember Sapphire, of course. She wasn't raised in a healthy environment, you know; I didn't get her till she was five. All those years around computers and fluorescent lights, with no magnets at all . . . no wonder she died so young." He shook his head darkly, looking up at *my* fluorescent lights with a disapproving frown.

"But, how old is Judy?"

"Sapphire had her litters, of course, and Diamond was the very best of her pups, born on my place and healthy till the day she died; oh such a tragedy, the day those coyotes came down from the hills."

I was concentrating on the task before me, only half listening. Poor Kami was never going to find out anything about Judy, but today it wasn't going to matter. Judy's pulse was fading away. I picked up my stethoscope and checked for her heartbeat. It was so faint I could barely find it, and even as I listened it stopped. It had all been too late, as I'd thought, though I'd gladly have been wrong this time.

I put down the stethoscope and looked at Ernest, who stared back with tearful eyes. "Thank you for trying, doc," he said hoarsely. "Thank you." He put a hand in his pocket, extracted some crumpled twenty-dollar bills, and put them on the table. He picked up Judy, holding her tight against his chest, and walked slowly out to his car.

I couldn't help contrasting this ragged and somewhat psychotic man with the truck dealer Donald Miller, who had brought me a cat in similar condition and accused me of murder when it had died on the table.

Not that I wanted to think about Mr. Miller. In the press of the afternoon's events I'd almost forgotten about my little accident. Now it all came back to me with awful clarity, the splatter of calf bodies and calf parts in what seemed to be Technicolor and surround-sound, with Mr. Miller at the front shouting *lawsuit* at the top of his lungs.

I locked the front door and went back to the exam room to help Tegan clean up. There was always something particularly depressing about putting things away after a death, disposing of antivenin bottles, needles, and catheters, all of which had proved to be useless. Tegan was very quiet. Watching her, I realized how much I missed her bright cheerfulness, the way she had once hummed or whistled as she worked. I even missed the vivid magenta spikes of her old hairstyle.

We worked side by side until the chaos of the emergency was cleared away. Then Tegan sat down on a chair, leaned back, and closed her eyes. She was so beautiful. She looked like an angel, even though she wore loose jeans, sturdy boots, and an iodine-stained smock. She had been letting her hair grow out, and soft black waves now fell nearly to her shoulders. She was thinner than she'd once been, and had dark circles beneath her eyes. I realized anew how much I loved her. What had happened while she'd been gone on her leave of absence? I had asked before, but she'd said she wasn't ready to talk about it, so I'd let it drop. I wondered if it was time to ask again. Probably not. Instead, I asked about her dog.

"So how is Mick doing?"

"Better, since he's been spending days at my friend Hannah's place. He plays with her puppy all day; it wears them both out, thank goodness. Wish I had a bigger yard. I ought to start looking for another place, but I'm afraid anything with a nice yard will be out of my price range."

If we pooled our resources and moved in together, we'd be able to afford a place with a yard—but no, this wasn't the time to say it. "It's too bad about Ernest's little dog," I said instead.

Tegan nodded. "You know, Ernest is a very strange man," she observed.

I nodded. This was certainly true.

"The man's seen aliens," Tegan said, "he's seen a glowing aura around people who've been in Los Alamos, he's sure that electrical lines are deadly and that magnets can work miracles, he sees giant talking birds that accompany the spirits of his dead dogs to heaven . . ."

"He may really be seeing those birds," I put in. "Vultures are big and his dogs are all small."

Tegan grimaced. "And sometimes I wonder about all the rest," she said. "Wouldn't it be interesting if all those crazy things he believes should turn out to be true?"

I opened my mouth to make a derisive comment, and then shut it again. I had, after all, seen stranger things with my own eyes. Who knew, really, what Ernest Davenport had seen?

The next day started well enough. I castrated three horses and vaccinated a trailer-load of cattle, and large-animal work always made me happy. And best of all, not one of these animals was dying. I had just finished with the cattle, and was making sure Aaron cleaned the squeeze chute and swing-around properly, when Kami came hurrying out to the barn.

"Dr. Clayton," she said, "there's somebody from your insurance company on the phone. He said it was *very important.*"

"Oh." I sighed. Oh well, I *had* been expecting it. I picked up the barn extension, trying to keep one eye on Aaron, who tended to wander away from work when he was not under close supervision. "Dr. Clayton speaking," I said.

"Hello, doctor. This is Roger Slate with the Western States Insurance Group. I'm calling to find out more about this incident involving, let me see, Mr. Donald Miller. It appears he's filed a claim against you."

"Oh. Yes. He did say he would."

"Could you tell me in your own words what happened?"

God, this was embarrassing. "I was on my way to the dump," I explained, "and I had a load of dead calves on the flatbed trailer. And—ha-ha!—apparently I didn't fasten the hitch correctly. The trailer got away from me and went right into the truck lot; it's incredible really because the flatbed's a two-wheeler, and can you imagine the odds of it being balanced so well it didn't just crash when the hitch came off?"

I paused, and there was a long silence. Unnerved, I went on. "But it was an accident, of course. Purely an accident."

Another long silence. I was about to start another panicked monologue when Mr. Slate said, "Um, I see. But what about the cat?"

"Cat? Oh no, no, no. Calves. There were calves on the trailer. No cats."

"No cats. I see. And these calves—"

"Dead. All of them. Or dismembered. Of course those were dead as well."

"Ah." Another long silence.

"It really was an accident," I blundered on. "And I'm sorry about the damages, but since it was an accident, that really couldn't be helped; I mean that's why they call it an accident, isn't it? I certainly didn't mean for anything to happen to Mr. Miller's property in particular."

"Well," Mr. Slate said, "that's very interesting, Dr. Clayton. I believe I'll have my supervisor get back in touch with you later. Thank you for your time."

Well, that had certainly been an odd conversation. I hung up the phone and went to chase down Aaron, who had left all the castration instruments, unwashed, on the counter.

In the afternoon I got called out to two calvings, both of which went smoothly and resulted in live calves. I did love a nice calving, and practically speaking, I was just as glad not to have any more dead calves that would have to be hauled off. Maybe I'd be able to put off the next dump run for a while—just thinking about it made me nervous. That insurance agent had been awfully strange, too. Why had he asked that odd question about cats?

Oh.

Donald Miller must have filed a claim about his dead *cat,* from last month. I had blurted out all sorts of information about the wrong incident. No wonder there had been so many awkward silences.

When I pulled in to the clinic Kami

was waiting with a message from another insurance agent, Karl Jones. Undoubtedly this was Mr. Slate's supervisor, seeking clarification. Without even pausing to check on Aaron's progress, I hurried to the phone and punched in the number.

"Good afternoon," said the voice on the other end. "This is Karl Jones."

"Oh, hello. This is Dr. Michael Clayton, returning your call."

"Oh yes. Thank you, doctor. I was calling about the incident involving Mr. Donald Miller, who has filed a claim against you. Could I ask you to tell me what occurred?"

"Yes, of course. Mr. Miller brought in his cat in a moribund state. The cat was in terrible shape, with a severe case of pyothorax. Labored breathing, high fever, chest full of purulent material. Whatever the man's told you, his cat didn't get into that condition overnight. When he brought it in it was very nearly dead. All I had time to do was pull out my stethoscope and check the breathing, and the cat died right there on the table. And personally I think I have a lot more cause for complaint than Mr. Miller does. The man immediately began shouting at me, accusing me of murder, when it was Mr. Miller himself who caused his cat's death by letting it get into such a condition. The situation was completely hopeless by the time he brought the cat to me."

I paused, and there was another long silence that was becoming all too familiar. At last Mr. Jones said, "Ah—murder? I don't see any mention of that in the complaint."

"Well, that's what he said, whether he admits it or not."

"I see." Another long silence. "So, how did Mr. Miller's truck get wrecked?"

"Truck?" I said in a small voice. "I thought you wanted to know about his cat."

"No. I don't have anything here about a cat." A short pause this time. "Just how many claims do you have filed against you, Dr. Clayton?"

I put down the phone, mortified, and put my head in my hands. Perhaps it hadn't been so clever to put all my insurance policies together in one company, even though they had offered a discount. I wondered dismally how much my premiums were going to rise, and how many more lawsuits I would be dealing with by the end of the year.

When I lifted my head I found Tegan in the doorway of my office, looking hesitant. "Michael?" she said. "There's no more appointments today, and I wondered if you'd mind if I went home early. I'm feeling tired."

This was so unlike Tegan that I couldn't think of a thing to say. It would have been par for the course for Aaron, who had once spilled soda on his carpet at midnight and had been too worn out by the ensuing scrubbing to come into work the next day. But Tegan was never tired. She was always bright and enthusiastic and eager to work. That is—she had been, once. She wasn't anymore.

"Oh, I meant to tell you," Tegan said. "I was going to order PDS suture today, but I found out that the Maxon is a lot cheaper. Would you be okay with using that instead?"

"What?" I stared at her stupidly.

"The Maxon's a lot cheaper. Should I order it instead?"

"That would be fine," I said. "Tegan, what's wrong?"

She looked startled. "With the Maxon?"

"No. With you. Can't you tell me?"

"With me? Nothing's wrong with me."

"But you've been so depressed lately. I've been worried."

"Oh, Michael. I'm just tired, that's all. You don't need to be worried." She turned to go. "Good night. I'll see you in the morning."

I sat there in my office, staring into space for another fifteen minutes. I had phone calls to make, bills to pay, charts to write in, and Aaron to supervise, but instead I sat and tried to analyze Tegan's behavior since she'd returned from her leave of absence. Was she really depressed, or was she just trying to keep some distance between us? We'd been in a romantic relationship when she'd left, but now that seemed to have disappeared. She'd gone out with me a few times since she'd returned, for dinner or a movie, but she had been quiet and distant at those times, as if her thoughts were far away. Was it me? Was it her? Was it something that had happened while she'd been gone?

"Dr. Clayton?" Kami said brightly, leaning into my office. "Howard Winston is on the phone. He says he has an emergency."

A chill fear settled over me, driving away even thoughts of Tegan, and I closed the door behind Kami and stared at the blinking phone. Howard Winston was one of my closest friends, and a devoted client, but I always dreaded his calls. In addition to horses, cattle, lizards, tortoises, and hermit crabs, Howard kept some very strange pets. A family of sea monsters lived in a large stock pond on his property, and although I was very fond of them—they were delightful creatures—it was hellish trying to provide them with veterinary care. They were a completely unknown species, and every time I treated them I had to rely on extrapolation, intuition, and guesswork, which was not the way I liked to work at all. Howard kept the monsters' existence a closely guarded secret, and would not allow me to consult with anyone else. With the sea monsters, I was on my own. And Howard had told Kami he had an *emergency*.

Praying that something was wrong with one of Howard's horses, I picked up the phone.

"Oh, Michael," Howard said anxiously. "I'm so glad you're there. Can you come out to my place? It's Curious; he's really gotten hurt this time, and it's just the most awful mess."

My heart sank. Not a horse, but a monster, and my favorite monster at that. And judging from Howard's shaky voice, the injuries must be serious.

"What happened, Howard?"

"I don't know, but it looks like he was caught in some sort of *cave-in*, and he looks terrible, Michael, just terrible."

My hand froze on the phone. Another major surgery on a monster—my worst nightmare—and it sounded as if Curious might die.

"What are you doing, Howard?" The faint voice was coming over the phone: Lynda, Howard's wife. "You'll give Michael a heart attack. Didn't you tell him it was just a laceration?"

"But it looks so *awful,* honey," Howard protested. "Um, Michael, Lynda says it isn't really that bad. But it looks *terrible.*"

Lynda had once worked for me, and was a world of difference from Kami. She could be trusted to know what was serious and what was not. I managed to start breathing again, and banished the visions I'd been having of Curious's death.

"All right, Howard," I said. "I'll be straight out."

I called Tegan, thinking she would want to come with me, but she didn't answer, and the machine didn't pick up. Either she wasn't home yet, or she'd gone straight to bed with the phone turned off. Well, as long as major surgery wasn't involved, Lynda would be able to give me all the assistance I would need with Curious. But it was going to be strange, driving the long road to Howard's ranch alone.

The sun was starting to get low on the horizon by the time I coaxed my truck around the last hairpin turn on Howard's horrendous ranch road. The truck jounced and jerked to a stop near the sea monsters' hidden pool. Howard and Lynda were waiting for me there.

"I'm so glad you could come, Michael," Howard said, blinking behind his glasses and peering past me. "But where's Tegan?"

"Ah, she didn't come with me. She was tired; she went home early today."

"Tired?" Lynda said blankly. "*Tegan?*"

"Is she all right?" Howard asked anxiously. "That really doesn't seem like her."

"I know," I said. "But that's what she said. She was tired, she needed to go home early. Now, let's go have a look at Curious."

Howard and Lynda exchanged worried glances, but let the matter drop.

All the monsters were delighted to see me, especially Curious. He plunged into the shallows and crawled half onto the bank, holding out a fin for me to grasp. He didn't really look as if he had been in a cave-in, but his huge spherical body was patterned with scrapes and scratches, and there was a long nasty-looking gash that ran alongside his blowhole. Perhaps he had been trying to get through an underwater passage that he had outgrown, thinking that he was still a smaller creature? I had a sudden sharp pang of nostalgia, remembering when I had carried all ten of the monsters around in a bucket. Now, Curious was more than twice as big as I was.

I examined him carefully, from his whiskery wrinkled face to his three-pronged tail, and breathed a sigh of relief. Lynda had been right. Curious' laceration looked dramatic but was actually superficial. I already knew that Curious could handle local anesthesia with no problem, so all I had to worry about was keeping him still through what promised to be a long and tedious suture job.

I took a new grip on his fin, trying to convey to him what I would need to do. *Touch* provided some degree of communication with the monsters; we could pick up on each other's emotions, but unfortunately that was all. I longed to ask him what in the world had happened to him, but as was true with so many of my patients, I would undoubtedly never find out. And he didn't seem to be at all concerned about his injuries. Through his touch I could detect pain, but it seemed mild, in the background. More strongly I could feel his trust in me, along with an odd feeling of maturity, or solemnity, which was not something I had felt from the lively and troublesome Curious before.

The other monsters floated nearby, watching as I started work on Curious's laceration. Lynda sat on the bank beside me, her feet in the water, passing me instruments and suture. Curious had rolled obligingly onto his side, so that I could more easily reach my work area, and it would be hard to imagine a more cooperative veterinary patient. He let out a low click or a whistle from time to time, but stayed admirably still. Lynda, who was visibly pregnant now, shifted position more often than he did.

"When's the due date?" I asked her, tying off a suture.

"Four more months," she said. "Four more *long* months." She looked at the watching monsters and gave an envious sigh. "The monsters have it so easy. You can't even tell when they're pregnant, and they only have to lay those tiny little eggs."

"*Lots* of tiny little eggs," Howard reminded her. He was sitting a little higher up the bank, studiously not watching me work. "After they hatch you have to raise ten babies, not just one." He shuddered, obviously remembering the time he'd spent bottle-feeding his family of monsters after their parents had died.

"Well, there is that," Lynda said. "I wonder how Caddy and Megamouth are getting on?"

I wondered that too. Caddy and Megamouth, two of the monsters, had mated last year, and had then moved out with the resulting offspring. None of us had any idea where they'd gone. There were vast water-filled caverns below ground here, connected with a maze of watery passages, some, apparently, too small for a very large monster to pass through. I didn't know how far the underground network extended, but I suspected that it was very far indeed. Caddy and Megamouth and their family could be almost anywhere.

After an hour's steady work, I finished suturing Curious's laceration. "That's it then," I said, struggling stiffly to my feet. Curious, looking as relieved as I felt, rolled gratefully into the water and swam out to his siblings. They splashed and touched noses, but didn't start any furious play. Were they being restrained because of Curious's injury, or was it something else? I remembered the odd solemn maturity I'd felt from Curious, and wondered.

Lynda gathered my dirty instruments, wrapped them in a towel, and put them in my bag. "Here you are, Michael," she said. "Thank you so much. Would you like to stay for dinner? We're grilling steaks, and there's peach cobbler for dessert."

Ah, dinner. I was starving, my back ached, and my feet were sopping wet. I pictured myself at Howard and Lynda's table, with a fire crackling nearby and delicious food piled high on my plate.

"Yes, please," I said happily, and my pager went off.

Not *now,* I thought, but there was nothing for it. I steeled myself and reached for my cell phone, hoping this would be something simple, like a puppy that had lost a baby tooth or a cat with an abscess. After an hour's drive and an hour's hard labor, surely I deserved a few minutes to eat. Nervously I punched in the number and waited.

"Hello, Dr. Clayton? This is Ernest. Ernest Davenport." The man's voice was anxious, and I groaned inwardly. Since Ernest had no phone, and had to trek to a neighbor's to use one, his calls were rarely about trivial problems.

"Hello, Ernest," I said with a sigh. "How can I help you?"

There was a long pause. Then Ernest whispered, "I don't know if I should tell you over the phone."

"I see," I said blankly. "Is there a problem with one of your dogs?"

"No, no. Nothing like that. My dogs are fine."

I tried to remember if Ernest had any other pets besides his dogs. He'd only brought dachshund crosses, one after the other, to see me, but of course I had no idea what sort of other creatures he might have at home. "Well," I said, "I'm glad nothing's wrong with your dogs. Do you have some other emergency?"

"I don't know. I just don't know." Ernest took a deep breath. "Dr. Clayton, I need for you to come out to my place."

"You do?" I said, astonished. Ernest had never divulged his address to me, in spite of Kami's efforts, and Lynda's before her, claiming that this was private and confidential information.

"Yes," Ernest said, "but you've got to come alone."

"Okay, I'll come alone, but can't you tell me something about what's going on?"

"No. I have to show you; it's the only way."

"Okay," I said, resigned.

"And don't bring any fluorescent lights. Or cell phones."

"Ernest, I have to bring my cell phone. I'm on call."

"Oh." There was a long silence, and I began to hope that he would tell me not to come after all. But instead he said, "Then I'd better adjust the magnets to account for it. Don't bring any magnets either; it'll upset the balance."

"Um, right." Did people often travel with fluorescent lights and magnets?

Finally, in a hoarse whisper, Ernest gave me directions to his home. It was about twenty miles away, more or less on the way back to my own apartment, which was at least some small comfort.

Lynda gazed at me sadly as I put my phone away. "Was that an emergency?" she asked.

I thought about it. "I'm not really

sure," I said at last. "That was Ernest Davenport. He wouldn't tell me what was wrong; just that I needed to come out to his place."

"Really! Out to his place? When did he decide to tell you where he lives?"

"Just now," I said.

Lynda looked worried. "I suppose that means it's not just an emergency, it's a crisis," she said. "I'm sorry you can't stay for dinner."

I was sorry too. But Lynda was right. Some sort of crisis was going on at Ernest's place, and I needed to be there.

I drove back down Howard's potholed road to the highway, which I followed for some miles until I came to a turnoff behind a crumbling old green storage shed. From there Ernest's directions grew more vague, as the landmarks he had described were almost impossible to find in the gathering darkness, and I had to backtrack several times when I ran into dead ends. I was not in a good temper when I finally rolled up to the tiny travel-trailer Ernest called home.

The trailer looked dark and uninhabited, but it had to be the right place. Was Ernest still on his way back from the neighbor's house where he had made the phone call? A man like Ernest might have to travel a long way before he found someone who would open a door to him, after all. But no, his car was here, parked close by the trailer. He had to be home. So where the hell was he? Surely he'd heard me drive up; it wasn't as if there was any other traffic. He really ought to have the courtesy to come out and greet me. Annoyed, I got out of the truck and slammed the door behind me.

But it was hard to stay in an evil mood once I was out of the truck. The air was cool and crisp, and the mountains looked mysterious in the light of the rising half moon. A coyote howled nearby, its voice wavering up into the sky. The half moon was huge and yellow, shining through a thin and patchy layer of cloud. I sighed happily. I did so love the desert at night.

Suddenly, another coyote howled, much closer, and I jumped. But no, it wasn't a coyote; it was a dog, a little dog with short legs. It appeared around the corner of the trailer, fixed its gaze on me, and growled.

"Save it," I told the dog, laughing. "You really aren't very frightening."

Approximately forty-nine other little short-legged dogs suddenly appeared beside the first one, and I gulped. There was an outbreak of massive growling, followed by a riot of barking, and then the whole mass of little short-legged dogs charged toward me. I blinked in disbelief, and then ran for the truck in blind panic. I was almost there when I tripped on a cactus and fell, jarring the breath from my body and all coherent thought from my mind. All I could think of was how the obituary would read: LOCAL VETERINARIAN KILLED BY WIENER DOGS. Then I heard a gun fire. It went off twice more, and the yammering barking abruptly stopped. I lifted my face out of the dirt and saw all the little dogs slinking away into the darkness. Ernest casually holstered his gun and offered me a hand.

"Thanks for coming, doc," he said, watching the lurking dogs affectionately. "Aren't they the sweetest little things?"

"Er, well, they don't seem to like me very much. I suppose they don't get many visitors."

"Oh, they like you fine," Ernest explained. "They get a bit enthusiastic, especially at feeding times, but all I've got to do is fire a few shots into the ground and they settle right down."

"Oh." I contemplated this. Apparently, Ernest experienced this behavior every day. Perhaps the little dogs had been rushing to greet me rather than chasing me down to kill me, but it was difficult to be sure.

"Anyway, I've got to show you what I called you about. It's this way."

He headed off, but I balked at this.

"Now wait a minute, Ernest. You've got to give me something to go on here. How else will I know what to bring with me?"

"Ah, you're right," Ernest said. "Well then. It started back when Delilah had that litter of pups—Patches was one of them, you'll remember her—and I was putting a bit more aluminum on the trailer walls; I'm sure you know how important that is. You really should consider putting some of it up at your clinic; I'd be glad to help."

"That's very kind of you, Ernest, but I really need to know what's going on."

"Yes, of course you do. So I was putting up the aluminum, and a flying saucer flew over. You should have seen the dogs then! I've never seen them so excited. We all watched the saucer until it went away, and then I went back to the aluminum, and it was just a month later that Mindy's pups were born, and poor Rascal got taken by the coyotes."

"That's very interesting, Ernest, but you were going to tell me why you called me out here tonight."

Ernest gave me a hurt look. "I *am* telling you, doc. Now, Mindy had seven pups as you'll remember, and one of them was Topaz; you saw him back when he had that awful infection on his foot. Well, Topaz grew up; he's over a year now, and one day he just took off into the hills, all alone, and I thought I'd follow him. Topaz, he's like that; always off on his own. Do you think I should be concerned about that? Doesn't seem natural. Dogs are meant to be pack animals, after all."

"Well—"

"So I followed Topaz, and he took me right up to the alien. We talked for a bit, the alien and me, and she said she'd like to stay for a time, and I said that'd be fine, so she's been over yonder and Topaz and me, we visit from time to time. And Topaz—Topaz! Where are you, boy? He was all frantic to go up there today, and we saw the alien and she was just lying there, not looking right at all, and she said I should call you, so I went down to a neighbor's and did."

I sighed. It seemed highly unlikely that an alien would have requested me by name, but it didn't seem worthwhile to point this out to Ernest. "So, you want me to take a look at this, um, alien you've found."

Ernest nodded. "She's not looking well at all, doc. Just kind of floating on the surface, see, and I've not ever seen her do that before."

"Floating?" I said hoarsely. "*Floating? She lives in the water?*"

"Yes, of course she does. Anything that big would have a hell of a time getting around on land, don't you think?"

I nearly fainted. Ernest wasn't hallucinating after all. He'd found one of Howard's monsters—Caddy or Megamouth, who'd left Howard's stock pond to set up housekeeping on their own. But he'd only described *one* creature, not two, and what about the baby monsters?

"Did you only see one?" I demanded. "Not two?"

Ernest looked startled. "Two? No, just the one."

"What about babies? Have you seen any babies?"

"You mean baby aliens?" Ernest said uncertainly.

"Yes!"

"Well no, doc."

I closed my eyes, fighting back fear. Anything could have happened to the others, anything, and the one Ernest had found was ill. *Please, please, don't let the others be dead,* I whispered to myself. I grabbed the large-animal bag out of the truck, hoping it would have everything I needed, and turned to Ernest. "Show me where it is. Quickly. There's not a moment to lose."

Ernest, taken aback, did not seem to be able find anything to say. He nodded, pulled out a flashlight, and set off at a brisk pace, with one little short-legged dog at his heel. He glanced back often to look at me, and then quickly looked away. Clearly he was wondering if he really wanted to have this psychotic madman at his back.

We climbed a steep rocky hill, which would have been quite challenging enough in the daytime, and between my fear for the monsters and the effort of the climb, I was soon gasping for breath.

"Sure you don't want to slow down, doc?" Ernest asked. Old as he was, he wasn't the least bit winded, and neither was Topaz, whose legs were probably only two inches long. It really didn't seem fair.

"No," I croaked. "Keep going."

The hill we climbed seemed endless, though according to my watch it took only twenty-five minutes to reach the top. On the other side of the hill the moonlight shone on a deep gully, and I saw the glint of water. I scrambled down the far slope at Ernest's heels, and came to a stop at the water's edge.

A large dark shape was floating near the bank. "Caddy?" I whispered. I knelt, slapping the water gently. "Megamouth?" The dark shape moved, and a slender head with huge limpid eyes turned to look at me.

It wasn't Caddy or Megamouth. It wasn't a sea monster at all. It was, in fact, something even stranger.

For a moment I couldn't even breathe. I'd seen this creature only twice before, and sometimes I managed to convince myself that I'd imagined both events. The only thing was, Howard had seen her too. We'd called her Stranger, because she was stranger even than the monsters. She was a good fifty feet long from nose to tail, slender and snakelike, with masses of fronds and streamers floating around her head, framing her great beautiful eyes.

That was all I knew about her, besides the fact that she was an egg-layer (on one occasion I'd helped her deliver an egg—an egg, sadly, with no life in it) and that she normally lived at much deeper levels. Seeing her at the surface probably meant that something was quite wrong.

I waded out to meet her, scarcely noticing the chill water rising over my boots and soaking into my jeans. "What is it, Stranger?" I asked softly.

Her gaze was fixed on me. I couldn't see more than the first few feet of her; the rest of her body trailed away somewhere in the depths of the pool. "Is it an egg again? Do you need help?"

Stranger ducked her head beneath the water, then lifted it. She extended a flurry of long fronds toward me. In the fronds she held a large egg.

I froze. It's never wise to come between a large animal and her baby, and I couldn't imagine what Stranger wanted me to do. Obviously she had needed no help in laying the egg, as she had done before. Uncertainly I stood still, looking from the egg to Stranger's eyes, and back again.

"Well, I'll be," Ernest murmured from behind me. "It *is* a baby alien."

After a moment Stranger swam closer and tried to push the egg into my arms.

I recoiled. "I can't! If your egg's not alive, there's nothing I can do," I told her.

"Oh, the egg's alive," Ernest commented from the bank.

"What?" I said, fending off the egg as Stranger pushed it toward me again.

"It's alive. She wants you to hold it, doc."

"What? How do you know that?" Suddenly the egg was in my arms, and I clutched at it. It felt warm, and faintly resilient, nothing like the dead egg I'd handled so long ago. It *was* alive. But why in the world was Stranger giving the egg to me? I had no idea what it needed in order to hatch. And I was worried about Stranger herself; I wanted to examine her, but I could hardly do that with an egg in my arms. What could possibly be wrong with her? Was she ill? Injured? Had completing the gestation of the egg debilitated her to this extent?

Helplessly I stood there in the water,

holding the egg. When I stepped toward the bank, Stranger quickly moved past me and gently pushed me back into the water beside her. This made no sense at all. She was insistent that I hold the egg, but just as adamant that I not take it away. I pictured myself still standing in the same spot in a week's time. No, I'd never make it. The egg was heavy, and my arms were already growing tired.

The air that had seemed so fresh and bracing when I'd gotten out of the truck now seemed fierce and chill. I stood waist deep in the cold water, shivering, feeling a stir of envy directed at Ernest, who sat on the bank, warm and dry, with the little dog Topaz in his lap.

Long minutes passed. The cold was seeping into my bones, and my arms were beginning to go into spasms. But just when I thought I couldn't hold the egg a minute longer, Stranger deftly plucked it from my grasp and slipped slowly down into the water.

"Wait!" I cried out, floundering after her. "You're ill, Stranger. Let me have a look at you! Maybe there's something I can do."

Stranger's great eyes gazed at me as she slipped away, out of sight and out of reach. I was left alone in the water, shaking with cold and completely bewildered.

What in the world did she want from me?

This question kept me awake half the night and was all I could think of on the drive to work the next day, but my first two clients nearly drove all thoughts of Stranger from my mind.

My first client was young Danny Vigil, whose Golden Retriever, Blossom, had been in on Monday with a laceration on her side. She was back today because she'd chewed out half the sutures.

"I'll have to keep her and stitch that back up, Danny," I said. "And then I'm afraid she'll need to wear a hood."

"You mean one of those lampshades?" Danny asked.

"That's right. Now, I can fit her in with the morning surgeries, so you can pick her up this afternoon if you like."

"Sure." Danny hesitated, then said, "Dr. Clayton?"

"Yes?"

"My roommate said I ought to sue you over this." His voice was so casual and amiable, it took me a moment to realize what he'd said.

"Excuse me?" I said faintly.

"I just wanted to check and make sure I can still keep bringing Blossom here if I do." He smiled.

"You want to sue me *and* keep coming here as a client?"

Danny nodded hopefully. I explained, as calmly as I could manage, that under the circumstances this would not be an option. He left looking disappointed, but without actually saying whether he was going to sue or not, and as I led Blossom back to the kennels, I pictured getting yet another call from an insurance agent, who would want to know how many claims I had filed against me *now*.

My second client, Mrs. Anderson, had brought in a Pomeranian puppy for a check-up.

"Here's what I'm concerned about," she said, efficiently prying open the puppy's mouth. "See? The teeth don't line up properly, do they? And that will cause all sorts of dental problems later in life, won't it?"

Carefully I began to examine the puppy's teeth, gently opening and closing its mouth to check the bite. There was a very slight misalignment, but it was almost undetectable.

"And this gives me good cause to sue the breeder, doesn't it?" Mrs. Anderson went on, without pausing for breath.

I twitched at the word *sue*, but at least this time it wasn't aimed at me.

"Well," I said, trying to sound soothing, "it's true that the teeth are slightly misaligned, but it's extremely mild, and it's doubtful that it will ever cause a problem. I shouldn't think there'd be any need for a lawsuit."

Mrs. Anderson's eyes narrowed. "No need for a lawsuit? No *need?* That breeder sold me *damaged merchandise.*"

I looked down at the puppy, and it panted cheerfully up at me. Damaged merchandise? "Surely you could simply return the puppy, if you aren't satisfied, and get your money back," I suggested.

She snorted. "I don't *think* so. That breeder *knew* this puppy was defective when she sold it to me. Getting my money back would hardly be sufficient." She turned back to me. "And I don't see how *you* can take this defect so lightly. Dismissing it and saying it probably won't cause harm. You don't know that for a fact, do you?"

A fine tension hummed in the air as I finished the puppy's exam and pronounced it healthy. Mrs. Anderson gave me a very dubious look, rolling her eyes and shaking her head at my diagnosis. "I can't imagine how you can justify saying that," she said, "but I haven't got time to get into it right now. I have to be at court at ten o'clock." She picked up her purse and her puppy. "I do like to schedule my lawsuits for Fridays, you see. I find that the judges are more likely to rule for me on Fridays."

She marched out, and I wondered if I was about to have a fourth claim filed against me. What was going on in the world today? Mrs. Anderson apparently made her living off of lawsuits, and even otherwise friendly people like Danny Vigil thought a casual lawsuit was a good idea. Maybe I should just close the clinic now and save myself a lot of trouble. There was no doubt about it; litigation was becoming far too common.

I was hesitant to enter the exam room with the next client, since the insurance company might well drop me if I got a fifth claim, but I managed to get through the rest of the morning's appointments without any more mention of suits. During the morning surgeries I told Tegan all about the first two unnerving incidents, and then, as the shock wore off, I remembered to tell her about Stranger.

"She just wanted you to hold the egg?" Tegan asked.

I nodded.

"That's so *odd.* I wish I'd been there."

"I wish you had been too. It was quite an evening, between that and Curious's injury."

I was resuturing Blossom's wound, and trying not to think about her owner. Truly, in many ways animals were much easier to understand than people were. Even Curious made more sense than Danny Vigil did.

Or did he?

I dropped my needle holders and thumb forceps, hardly noticing when they clattered to the floor.

"Michael? What is it?" Tegan was already pulling out another set of sterile instruments for me.

"I just thought of something. Curious. He wasn't distressed about anything. Neither were the other monsters. And last time Stranger was ill, they were all nearly frantic. It doesn't make sense."

Tegan looked puzzled. "Then maybe Stranger isn't really that ill. Maybe that means she'll be fine."

I shook my head. "No. If you'd seen her—no. She really is that ill." I took the fresh instruments and set back to work on Blossom. "And I'll bet Curious got hurt trying to go and see her. Maybe there really *was* a cave-in sometime, and he couldn't get through."

"But then why wasn't he upset?"

I shook my head again, baffled.

"Do you think Stranger is trapped then, at Ernest's place?" Tegan asked.

I thought of that underwater labyrinth, which Howard and I had once explored with diving gear. There were tunnels and passages everywhere.

"I don't think so," I said. "She may be cut off from Howard's pond, but there ought to be lots of other places she could go. I think she stayed there because she liked Ernest. They seem to understand each other."

Ernest had blithely mentioned having

conversations with Stranger, which I had dismissed out of hand along with his flying saucers. But what if those conversations had been real? Maybe Stranger *had* requested me by name.

"Dr. Clayton?"

I started, nearly dropping my instruments again. It was Kami.

"Excuse me," she said, "but there's an emergency here."

I was even more startled when I found that the emergency was none other than Ernest Davenport himself, sitting on a chair in the exam room with a small cardboard box in his lap. His face was ashen, and he looked ill.

"What's happened, Ernest?" I asked.

"It's Tootsie's first litter," he said hoarsely, looking down at the box. "She wouldn't feed them—kept trying to get away from them—I put her in a box with them so she'd have to take care of them—my fault—"

"Take it easy, Ernest," I said. "Here, let me see."

I took the box from him and looked inside. Three newborn puppies lay on a rumpled towel, mewling and squirming. Two of them looked fine. The third struggled feebly to move, bleeding freely from a completely severed hind leg. I pulled the injured puppy out of the box to examine it more closely, and Tegan gasped, and turned pale as a sheet.

"Tootsie's a good dog," Ernest said miserably. "Always has been. But she wouldn't have anything to do with her pups. There were five, you know. She killed the other two. Why would she do that, doc? Why would she turn against them?"

"It just happens sometimes, Ernest," I said, putting pressure on the gaping wound. "It was her first litter, you said. She probably just didn't understand what was happening, and didn't know what the puppies were. If this happens again with one of your dogs, you'll want to separate them and bottle-feed the pups. Or at least only put them with the mother to nurse when you can supervise them."

"But I thought mother dogs always knew what to do," Ernest said. "All my other dogs did."

"Most of them do know. But some dogs just aren't cut out to be mothers, Ernest. It isn't Tootsie's fault, but it would really be best not to breed her again." I stopped, thinking of that free-wheeling interbreeding mass of wiener dogs. There was no way Tootsie was going to avoid being bred in *that* environment. Would Ernest let me spay her? He'd always refused my spay-and-neuter advice before, with much the same polite but dismissive attitude that I expressed toward magnets and aluminum.

"What about this little one, doc? Has it got any hope?"

"Maybe," I answered doubtfully. The external damage was severe, and there might be internal injuries as well. "I'll do what I can, Ernest."

In the treatment room Tegan assisted me with the injured pup, standing white faced and silent while I tied off blood vessels and sutured the tiny stump of the leg. When we were finished she washed the instruments just as silently, but slowly the color began to come back into her face, and she looked better. As I put together a package of puppy formula and bottles for Ernest to take home, I wondered what had been wrong. Blood did not bother Tegan, and she had dealt with plenty of injured puppies, but something about this case seemed to have disturbed her deeply.

Ernest looked horrified when I presented him with the bottles and formula. "You have to feed them how often? For how long?" he said, aghast. "I don't know, doc. I don't think I can do it; I really don't." He was practically shaking with distress.

I sighed, mentally saying good-bye to sleep for the next week. "Never mind then, Ernest. I'll see to them."

"Thank you, doc," Ernest said gratefully. "Thank you. You don't know how much this means to me."

"You're welcome." I hesitated, then decided this was too good an opportunity to miss. "It would mean a lot to me if you had Tootsie spayed, Ernest. So this doesn't happen again."

Ernest usually looked maddeningly blank when I said the S-word, but today he looked thoughtful. "It might be a good idea, at that," he said. "People are funny about that sort of thing."

Had Ernest actually said *it might be a good idea?* I stood gaping at him.

"See, I was talking to the alien, Miss Stranger, that is," Ernest went on, "and she said that her and me, we're alike. I couldn't figure it for a while, but then while I was driving here it came to me, and I knew what she meant. Say, doc, could I put up a notice on your bulletin board?"

"You were talking to Stranger?" I blurted out. "Today?"

Ernest nodded. Tegan, who had already busied herself feeding the puppies, looked up at this, her eyes wide.

"How is she?" I said anxiously. "How did she look? How did she act?"

Ernest considered for a moment. "Happier," he said at last. "She was worried about her egg, but now she knows it'll be all right."

"She does? Are you sure? Did you see the egg?"

"No, no. The egg, it's not for me." He leaned toward me and said conspiratorially, "It comes from spending too much time around those folks from Los Alamos, I expect. They glowed in the dark, you know."

"Oh," I said blankly. "But about Stranger. Shouldn't I come out to check on her tonight?"

"Oh yes, doc. I was just about to tell you, that's what Miss Stranger said. She asked if you could come by tonight."

I nodded. "I'll be there. I'd like to bring Tegan too, if that's all right with you."

"Oh, that's fine," he said, as casually as if he'd never kept his home a secret. "I'll see you tonight, then. And what about that bulletin board, doc?"

What the devil did the bulletin board have to do with anything? "Excuse me?"

"I could put up a notice there, couldn't I?"

"Oh! Yes, of course. Of course."

"Thank you, doc. It's good to be prepared, you know. Thanks for minding them pups." He strode briskly out of the treatment room, and was gone. Tegan, feeding a puppy, thoughtfully watched him go.

On the drive to Ernest's that night, Tegan said abruptly, "He didn't post a notice, you know."

"What?"

"On the bulletin board. Ernest didn't post a notice. Do you suppose he's putting something together now, to post later?"

"I suppose so," I said a little blankly.

"Don't you wonder what he's going to put up there? Maybe he's gotten into magnet sales; he'd be a natural, after all. Or he's starting a UFO experiences club."

"I didn't really think about it," I confessed. "I'm still in shock about being allowed to spay Tootsie."

"It is wonderful, isn't it? I'm so glad he agreed. Just imagine how awful it would be if Tootsie had more puppies." Tegan's hands tightened in her lap, and she shivered. "What you said was so right, Michael. That she's a good dog, but not cut out to be a mother. It's so simple. It's funny I never thought of things that way before. It explains a lot."

"Explains what?" I asked.

"Oh—my family." Tegan looked down at her lap. "My trip home."

She certainly had my full attention now. "Did you want to talk about it?" I asked cautiously.

"Yes, actually. It doesn't seem so hard anymore." She took a breath. "I went to see my mother, Michael. I hadn't seen her since I was fifteen. She threw me out of the house then, and told me never to come back."

"What? But why?"

"I dyed my hair. Purple, I think it was."

"She threw you out because of your *hair?"*

Tegan nodded. "I suppose it was the last straw for her. Everything I did seemed to upset her, really. I went to stay with my grandmother while I waited for her to cool off. Only she didn't, and I didn't ever go back home."

"But—what about your father?"

She shrugged. "I never knew him. Anyway, a while back my grandmother found out that my mother had cancer. She'd had it for a long time, and now she was dying. So I went to see her, to say good-bye. I didn't want to upset her, so I covered up my tattoos, dyed my hair back to its natural color, did everything I could to be normal. But it didn't work. She refused to even see me. I stayed close by, in case she changed her mind, but she never did."

"You mean she died, without ever speaking to you?"

Tegan nodded. "I was having a lot of trouble dealing with it. Well, I expect you noticed. But I think I see it now. You said some dogs simply weren't cut out to be mothers. I expect some people aren't either, and it isn't their fault, is it?"

"No," I said quietly. "No, it isn't."

Ernest was waiting for us outside his trailer, and in the moonlight we could see a multitude of little dark shapes lurking in the shadows behind him. I got out of the truck cautiously, cringing back against it when the dogs charged and the gunshots went off. Tegan prudently waited for the furor to die down before exiting the truck.

"Thanks for coming, doc, Miss Tegan," Ernest said, holstering his gun and giving us a friendly wave of his flashlight. "How's the little pup doing?"

"He's holding on so far," I said, hoping that this was still true. Aaron was taking care of the puppies until I got back, and I was rather nervous about how well he was going to manage. It would really be best if I weren't gone for very long. "We're ready to go, Ernest, if you are."

Ernest nodded amiably and set out, flashlight in hand and little Topaz at his heel. Tegan and I followed behind them. I'd expected to have to push hard to keep up with Ernest, but tonight he was setting a much slower pace, probably, I imagined, out of deference to my gasping struggle last night. We toiled up the long hill, and at long last crested it and started down the other side. The huge pool lay below us, still and silent. I hurried to the edge, Tegan beside me, and stared out over the water.

"Where is she?" Tegan whispered.

"I don't know. Ernest?"

He was settled behind us on a nearby rock, with Topaz curled up beside him. "She's coming," he said. "Give her a minute."

A very short time later the water rippled, and Stranger lifted her head above the surface.

I almost cried out. She looked terrible, all skin and protruding bones, much worse than she had looked even last night. I splashed into the pool, trying to reach her, but she pulled away from me.

"Please, Stranger," I said, holding out a hand. "Let me help you."

"She says you can't help her, doc," Ernest said placidly from behind me. "There's nothing wrong with her that needs curing."

I spun around to face him. "What do you mean? Look at her!"

He chuckled. "Ah, she knows she looks like hell. But it's not sickness, see? She's old, that's all. There's nothing to be done for that."

"You don't know that," I cried, but Tegan was suddenly in the water beside me, reaching out to take my arm.

"I think he does know," she said. "Look."

I looked at Stranger. Her great beautiful eyes were looking past me, her gaze fixed on Ernest, and the fronds around her face rippled in the air as if they were flowing through water. She turned her head slightly then, to look at me, and I felt weak and dizzy.

"She's really talking to him?" I whispered to Tegan. "He understands her?"

"Yes," Tegan breathed.

Stranger lowered her head beneath the water, then lifted it again. Her egg was cradled within a myriad of fronds.

"She wants you to take care of the egg," Ernest said, "because she won't be able to. It's her time, and she's dying. All you got to do is keep the egg wet, till it hatches. It won't be long, just a couple of days. The baby, it's already bonded to you, from the last time you were here."

Stranger swam up to me and carefully pushed the egg into my arms. Numbly, I took it.

With a swirl of fronds, Stranger turned and dove beneath the surface. The water rippled behind her, and then was still. She was gone.

Ernest brought in his notice the next morning, and pinned it to the bulletin board. It was Saturday, always the busiest day of the week since we closed early, and I didn't get a chance to look at it till all the appointments were done.

TO GIVE AWAY TO GOOD HOMES, A WHOLE BUNCH OF CUTE LITTLE DOGS. CONTACT DR. CLAYTON IF YOU'RE INTERESTED.

"What does he mean, contact Dr. Clayton?" I sputtered to Tegan. "What have I got to do with this?"

"Well, Ernest doesn't have a phone, does he?" Tegan said reasonably. "It's not as if anyone can contact *him.*"

"He could have at least *asked* me if it was all right to use my name," I grumbled. "Aren't I doing enough for him already, feeding all those puppies round the clock?"

Tegan gave me a look and I flushed. All right, so Aaron and Tegan had done almost all the feedings so far. I fully intended to do my share, as soon as I got the time.

"Seriously, though," Tegan said, "why in the world is he giving away his dogs? I mean, he adores every one of them."

I shrugged. "Maybe he's finally realized he has too many? He's getting older, after all. Maybe he's having trouble keeping up with them all."

"Maybe," Tegan said doubtfully. "I think it's strange, though. Ernest's changed so much lately."

"Tegan," I said. "He really did understand Stranger, didn't he?"

She shivered. "Yes."

"Do you suppose he could understand the sea monsters too?"

Her eyes widened. "I never thought of that! Would Howard let us bring him out to his place, do you think?"

"He might. I mean, even if Ernest did tell anyone about the sea monsters, nobody would believe him. It would be perfectly safe."

"Let's call Howard," Tegan said.

But as we turned away from the bulletin board, Mrs. Gallegos burst through the door, her poodle Fluffy clutched in her arms.

"Oh, Dr. Clayton! You're here! Please help me, Fluffy just collapsed."

I quickly led her into the exam room and she put Fluffy on the table with shaking hands. The little poodle was utterly still, and I didn't even need my stethoscope to know what had happened, but for Mrs. Gallegos' sake I pulled it out and listened carefully to Fluffy's chest. The little dog's body was still warm and relaxed, but her heart had stopped beating, her lungs had stopped working.

"I'm sorry, Mrs. Gallegos. I'm afraid she's gone. I don't think she suffered at all, though. She was very old, and it was her time."

Like Stranger. I saw again, in my mind, the great beautiful head disappearing under the water. Gently, I stroked Fluffy's limp head, and carried on with the painful questions about what Mrs. Gallegos wanted done with her dog's remains. She had finally decided to bury Fluffy at home when Kami knocked hesitantly at the door.

"I'm sorry, Dr. Clayton," she said, "but I thought I ought to tell you. The *police* are here to see you."

"Oh," I said nervously. "Um—put them in the other room, why don't you. Mrs. Gallegos, I'll just go and get Fluffy ready to go for you. I'll be right back."

As I dug through the boxes in the storage closet, looking for one the right size, my mind was spinning through reasons why the police might be here. Had they finally decided to arrest me over the calf parts incident? Donald Miller, as I recalled, had been very much in favor of that scenario. Had I forgotten to pay one of my many speeding tickets? Trooper Roger Whitman had given me most of them, passing them out with an unseemly and vindictive pleasure whenever he caught me, but none of the police seemed to understand that I would never make it to all my farm calls without speeding. Suddenly another even worse scenario came to mind, but surely the police would not know, or care, about the very large egg currently residing in an aquarium at my apartment?

I still hadn't found a box the right size. "Here," Tegan said, materializing in the closet beside me. "I know just the one. It's sad, really. Every time a cardboard box comes through here, I evaluate it for its coffin potential." She handed me a sturdy vitamin box, which was indeed the perfect size. We carefully settled Fluffy's body inside it.

Once I had given the box to Mrs. Gallegos, I could think of no more reasons to delay. I took a deep breath and opened the door to the exam room where the police were waiting. One was a stranger to me, but unhappily the other was Roger Whitman.

"Ah, Dr. Clayton," Roger Whitman said. "What a change, to see you without giving you a ticket. But I'm afraid I still have some bad news for you."

"Bad news?" Every scenario I'd thought of was bad news, so this really didn't clarify things very much.

He pulled a sheet of paper from his pocket and unfolded it. "I understand you're a close acquaintance of Mr. Ernest Davenport?"

"Yes," I said cautiously, wondering what Ernest had to do with anything.

"I'm sorry to have to inform you, but Mr. Davenport has died."

"Died?" I said blankly. "But he was just here. He put a notice on my bulletin board."

"He was found on a park bench, about an hour ago," the other officer put in. "Apparently, he looked quite peaceful, like he'd just drifted off. He was carrying a card that listed you as the contact person in case of emergency. Do you know of any family members we should notify?"

"No," I said. "No, I don't think he had anybody." Except for the fifty little dogs, of course. What was going to become of them? TO GIVE AWAY, A WHOLE BUNCH OF CUTE LITTLE DOGS. Dear God. Had Ernest *known* he was going to die?

Tegan echoed the question, once the police were gone.

"He must have," I said. "That's why he was giving away all his dogs. That's why he couldn't take the egg, or bottle-feed the puppies. He knew he wouldn't be there to take care of them."

"But how could he know?"

I shrugged helplessly. "He was Ernest," I said. "He wasn't like anybody else."

"No," Tegan said. "No, he wasn't."

We sat in silence for a moment, thinking of Ernest. The officer had said he'd looked peaceful. Looking back, that seemed right. Ernest had said he and Stranger were alike. They'd both known that their time had come, had accepted it calmly, had made arrangements for their dependents to be cared for. . . .

Those fifty little dogs were mine, now. What was I going to *do* with them?

"Dr. Clayton?" Kami said apologetically, breaking the silence. "Mrs. Gallegos is asking about the notice Mr. Davenport put up, about his dogs."

"Asking? Is she still here?"

Kami nodded. "She was awfully shaky, so she thought she'd better sit down for a while before she tried to drive. That's when she saw the notice."

I felt a stir of hope. Was it possible that I might now have only forty-nine little dogs to find homes for? Of course the fifty I'd started with was only an estimate, and I'd forgotten to count the three newborn puppies, but however many I had now, one *less* would surely be an improvement.

"Oh," Kami went on, "I almost forgot. The lawyer for your insurance company is on the phone."

Ah, yes. There was death all around me today, but life, and lawsuits, still trundled determinedly on.

On Sunday, Tegan and I took the egg to Howard's place.

"Tegan!" Lynda said happily. "Look at you. I love your hair."

I loved Tegan's hair too, not least because it signified the recovery of her usual bright self. She hadn't gone back to the magenta spikes, but had moved on; her shoulder-length hair was now colored in vivid tabby stripes.

Together we hauled out the big bucket containing the egg and lurched down the slope with it to the bank of the pool. The monsters all hovered eagerly at the pool's edge, eyeing it with fascination. Curious splashed out of the water, heaved himself onto the bank with his flippers, and poked a fin into the bucket to touch the egg. Tegan's dog Mick, who had come along for the visit, ran a few laps around the pool, a black-and-white streak, and then jumped in.

"So how many dogs do you have now, Michael?" Howard asked.

"Forty-five," I answered.

"Good Lord. Where are you keeping them all?"

"In the barn, mostly." Yesterday afternoon had been a truly surreal experience, driving out to Ernest's place in a borrowed SUV stuffed full of pet carriers, with Mrs. Gallegos in tow. *I saw the notice first, so I should get first pick*, she'd said, and had proceeded to take over the entire adoption process. She'd selected Topaz for herself, and had then photographed all the other dogs (there had been forty-nine total, not counting the newborns), contacted the newspapers, and printed flyers to put up all over town. It seemed to be her way of dealing with her grief, and I hadn't been about to interfere. Three more dogs had been adopted this morning, and I was expecting a flurry of queries come Monday.

Even more startling, Aaron had decided to adopt Tootsie's puppies and had volunteered to take over all the rest of the feedings himself. At this rate I'd be back down to my usual two tortoises by the end of the month.

Almost down to that. There was the egg, of course.

As if it knew we'd arrived at the pond, the egg began to rock back and forth in the bucket. I reached in instinctively and pulled it out to hold it in my lap. The shell suddenly split, all the way across the egg, and a tiny face with huge luminous eyes peered out. I peeled away the shell and the beautiful little creature curled into my hands, her long sinuous body graced with ethereal fronds. She was a perfect miniature of her mother, just as I'd known she would be. The others had wondered if there would be more stages in the life cycle (the sea monsters had several, between egg and baby monster), but I had known better.

The little creature looked at me for a moment, fronds waving around her face, and I got to my feet and carried her to the water's edge. Curious hovered solicitously beside her as I released her into the water, and the two of them disappeared together beneath the surface. The other monsters proceeded to chase Mick out of the water, and the dog made an undignified scramble, tail between legs, to flop down by Tegan's side.

I let out a sigh of relief. "She's going to be fine," I said. "Perfectly safe, with all these uncles and aunts to look after her."

"She?" Tegan looked at me quizzically.

"Well, she, um—looks like her mother," I said weakly. I didn't know how to explain how sure I was that the little one was female. Somehow, it seemed that she had *told* me. "In fact, I think I'll call her Junior."

"I wish her mother could have lived to see her," Tegan said wistfully.

"Yes. But Ernest was right, you know. She was old, very old, and it was her time. We're used to thinking that any animal of breeding age can't be so very old, but it doesn't seem to be so with these creatures." A thought struck me, and I turned to Howard. "That's *it,* Howard," I exclaimed. "That's what happened to the monsters' parents. I don't think they were ill at all. They were *old,* and they were wasting away just like Stranger did. They came to you so that you'd take care of their babies." What a relief it was to realize that; for years I'd been afraid that the parents' "disease" might crop up in Howard's monsters, and that I wouldn't have the faintest idea what to do about it. A great burden lifted, and I felt as if I might float away on euphoria.

Junior and Curious suddenly appeared again, and I waded out happily to join them, with Tegan at my side.

We were all sopping wet on the drive home. Tegan dried her striped hair vigorously with a borrowed towel, then shook it out, and Mick, very muddy as well as wet, tried to climb into my lap.

"We've got quite a collection now, haven't we?" Tegan said. "Forty-six dogs counting Mick, two tortoises, and Junior. We'll have to find a place with a really big yard."

We? Find a place? My heart started beating faster. "We're not likely to find a place to keep Junior. I think she'll need to stay fostered out with her aunts and uncles. And I'm really hoping to find homes for forty-five of the dogs."

"Forty-four," Tegan said thoughtfully. "I think I'd like to keep Tootsie. Mick gets along with her nicely. My apartment definitely isn't going to be adequate anymore."

"I'd like a bigger place too," I said, reaching over Mick to take Tegan's hand. "I'd like a place that's ours."

"Good," Tegan said simply. "That's settled, then."

I was floating for the rest of the drive back to town, and scarcely even noticed the heavy traffic that appeared as soon as we reached the city limits. The county fair was on this weekend, and everyone in town seemed to be out and about. Maybe Tegan would like to come with me to the fair, as soon as we'd changed out of our wet things and dropped off Mick. Maybe after that we could go out to dinner and celebrate.

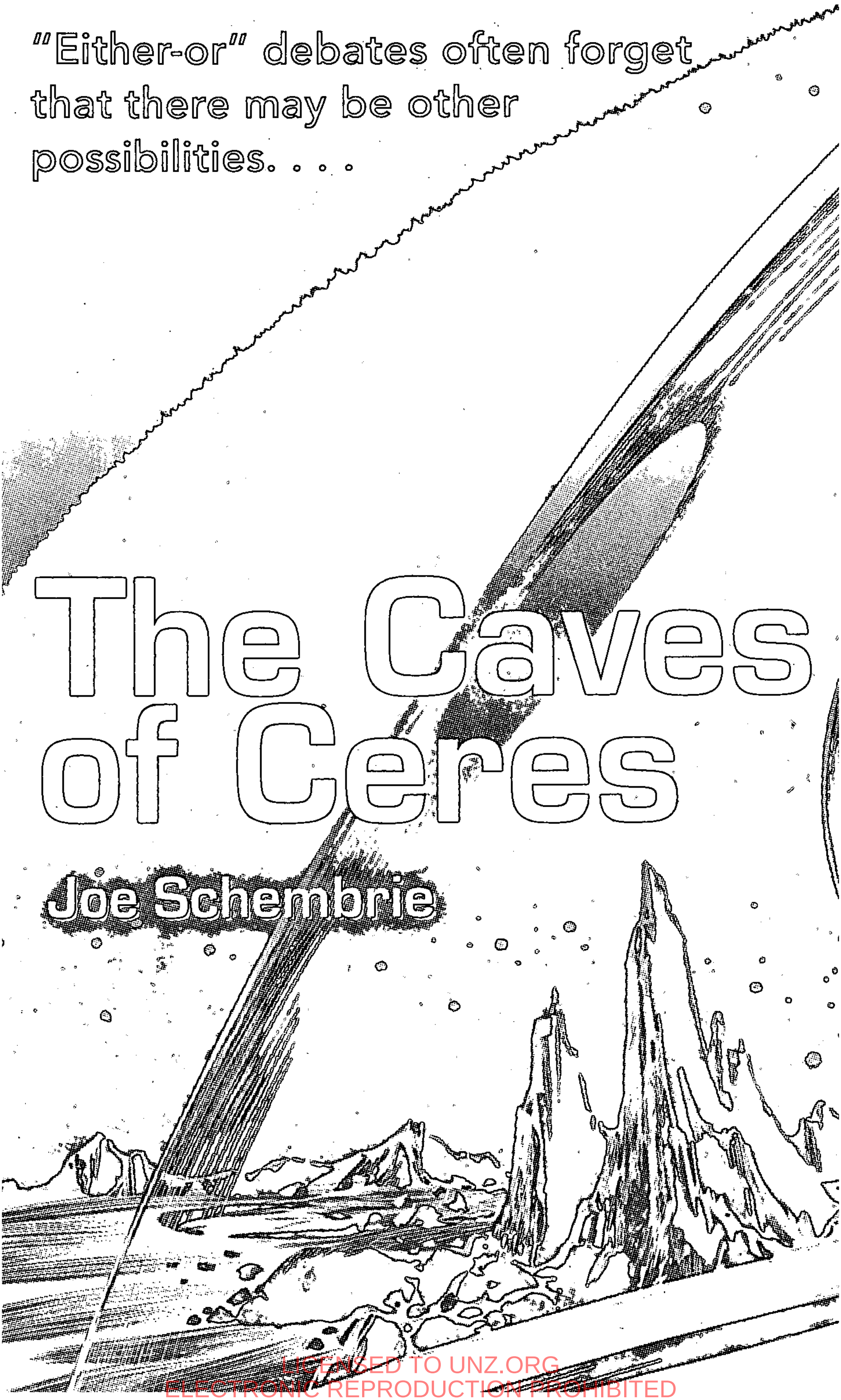
"Look out!" Tegan yelped, pointing ahead.

Someone had slammed on the brakes several cars ahead of us, and each successive car screeched to a frantic halt in a relentless chain reaction. I slammed on my brakes too, but the truck plus the vet box had a considerable mass, and I couldn't stop in time; with a thudding crunch I hit the bumper of the car in front of me. It was hardly fair, as I hadn't even been speeding, but nothing was going to disturb me today.

Even after the car door opened, and Donald Miller stepped out and fixed me with a furious glare that promised yet another lawsuit, it was still the best day of my life. ■

(EDITOR'S NOTE: Michael and the monsters have appeared previously in "Little Monsters" [November 1989], "Business as Usual" [July 1991], "Strange Things" [June 1992], "Yellow and Orange Blues" [May 1998], "As Time Goes By" [July/August 1999], "Sea Changes" [April 2002], and "Language Lessons" [October 2005].)

"Either-or" debates often forget that there may be other possibilities. . . .



The Caves of Ceres

Joe Schembrie

Illustrated by Vincent DiFate

As Roger Thomas flew his flivver through the caves of Ceres, a wall of rock popped into the headlight beam and he stomped the retro pedal. The helmet glass of his space suit automatically tinted with the flare of the rocket exhaust. Around the curve came a robot hauling wagons of ore. With a pulse of his side thrusters, Roger squeezed by. He ignored the sparks as an outcropping scraped bumper metal.

The tunnel opened into a cavern. The flivver settled with a ballistic spray of dust. Excavators resembling mechanical dinosaurs chewed rock while a humanoid robot glared with expressionless lenses at the human pawing under the vehicle's netting.

"Drill fuses," Roger said, flicking a package with a spin.

The robot caught clumsily. It flashed an authorization code into Roger's computer tablet and promptly about-faced.

"You're welcome," Roger said.

He thrust the way he'd come. His dash-mounted laser-ring gyro-map showed a blip ascending toward the Rift mouth. Seconds later, he pulled into a cavern as large as Manhattan Island. Along the frost-encrusted walls, men and machines enacted an arcane choreography upon scaffolding as slender as knitting needles.

A space suit with the blue-and-white Ceres Mining logo on its chest bounced over.

"Hey, Grady," Roger said. "Got a big one from your corporate slave drivers."

Grady Olsen gestured at the bumpers. "Looks like you've got some new bruises too."

"Either I drive faster than the robots do, or go home."

"You could also rejoin CM."

"That's going backwards."

"How you exit a dead end."

Roger unnetted a refrigerator-sized box. Not a lumbar-popper in Ceres's .025 Earth-standard gravity, but cumbersome. Grunting, Roger dumped the load onto a pallet.

Suddenly, Grady touched his helmet. "Hey, Roger, just got a message from my supervisor's office. Hal Winkler wants to contact you, urgent."

Roger glanced at his computer tablet, whose long-range communications functions were useless in the caves. "Wink? What for?"

"Something about a guide job. You're conducting tours now?"

"If it floats food above the table. But why is Wink drumming business for me? I haven't been in his place for months. He overcharges, you know."

"And waters the beer. I'm just the messenger. By the way, you didn't forget?"

"Do I ever?" Roger made a slow-motion football pass with an airtight container. "Synthetic pastrami and artificial rye. Hope you didn't want the other way around."

Grady snatched the sandwich. "I owe you."

"Big time."

Authorizations traded, Roger returned to the main shaft. He hovered, pondering whether to continue his rounds or see Wink. They weren't buddies, but Roger couldn't picture Wink pulling his leg.

Merging into the surface-bound traffic, Roger weaved among transports and ore carriers until he burst from the Obarator Rift. He headed over Planum Ferdinandea, increased his velocity by three hundred meters per second, and inserted into equatorial orbit. A star gleamed in the black sky above the geometrically patterned lights of Schroter Base. Alphaville Station resolved into a cylinder of multitiered windows pirouetting with a counterweight of slag at the end of a two-kilometer tether.

Roger matched orbital and rotational vectors and plunked onto the landing platform. While his legs adjusted to the full-Earth spingrav, he eyed his flivver.

One headlight was broken from that cave-in last week in Tunnel 18A. The passenger-side rear strut was crimped from when he had flown too fast through the fog in those new tunnels at the nine-thousand-meter level . . . well, the damage hadn't mattered until he wondered how a customer might react.

Sighing, Roger headed for the mall deck airlock.

The dining room of Wink's Interplanetary Bar & Grill was jammed with the usual suspects—miners, prospectors, technicians, drifters, quasicriminal lowlifes. Fitting comfortably into the middle of that milieu, Roger entered unnoticed.

Hal Winkler, looking more a waiter than the station's foremost entrepreneur, held a towel and had his sleeves rolled to display his skull-and-crossbones tattoo. As Roger neared, Wink spoke to someone at a table. With a jolt, Roger realized the person seated was female.

She wasn't bad looking: young, blonde, a smooth olive complexion with a nose that seemed to actively tussle between half-Aztec broad and half-Irish upturned. Her liquid eyes were wide and riveted on what Wink was saying.

Once Roger was in range, Wink slapped him on the shoulder.

"Rebecca, this is Roger Thomas. Roger, this is Rebecca Sanchez."

"Thomas," Rebecca said, her clear diction tinged with a Texan drawl. "Your last name is Thomas."

"Yes." Her steady gaze almost compelled him to apologize. "I understand you're needing a guide."

Over folded arms, she stared.

"Can I sit?" he asked.

With her nod, he slid into the chair. He became conscious of the sidelong glances from the other patrons. *You'd think they'd never seen a woman before,* Roger thought. And here there'd been one on the station only last month.

Wink hung over them. Rebecca forced a smile.

"If you don't mind. . . ."

"Oh, sure. I'll leave you to business."

Once they were alone, she gave Roger a gaze that felt like she was memorizing his facial pores.

"Well," she said. "So what's the message?"

"The message," Roger said slowly.

"Didn't my father tell you?"

"I'm afraid I don't know what you're talking about."

Her smile faded. Beads of moisture welled. "You don't know. I came all the way out here and—and—"

Roger heard the background chatter diminish. Glances turned to glares. He knew what they were thinking. It was his barroom fantasy, too, to be the shining knight who saved the noble lady from the boorish knave.

"Hey," he said softly. He offered her a napkin and she dabbed her cheeks. "This must be mistaken identity, that's all. So you're looking for a Roger Thomas?"

"Actually, someone named Tom."

"Just Tom?"

She breathed deeply. "I suppose there are lots of Toms out here."

"I'm afraid so. Ceres isn't one little outpost anymore. It has several communities, thousands of people."

"There's no directory?"

"If there was, we'd swing the publisher by the neck at ten gees." He paused. "Although, come to think, there is one listing." He brushed away her computer tablet. "You can't access via Asternet. It's private."

"I'll pay for your trouble."

Placing his hormones in standby mode, he took a financially appraising look. Her coveralls were not designer label. She was barely beyond her teens. And if she had paid for passage from Earth, she'd likely be low on funds. But for some reason, possibly that his hormonal-mode regulator seemed inoperative after ages of disuse, he trusted her.

"It's a deal." He noticed a handmade, long-necked bottle by her elbow. "Shall we toast?"

"Not that stuff." Rebecca laughed. "My father is an amateur winemaker, and it's one of his more, uh, creative attempts."

"Oh, sentimental value—"

"No way. It's just that I was to meet Tom at the storage room that my father leases here on the station. While I was waiting, I unlocked the room, and it was stacked to the ceiling with these bottles. I had a sip, and—well, I wouldn't want to afflict you."

"Rebecca . . . I assume you can't contact your father to ask about Tom."

"My father isn't . . . available." Her faced showed pain, then managed another smile. "How about I buy what you like?"

She signaled Wink. Roger requested a light beer. Wink did a double back and said, "Hey, Rog. Noticed your flivver's kind of beat up. Why don't my garage 'bots do a go-over while you're here?"

"I'm short on cash."

"Your credit's good."

Wink grinned at Rebecca. But Roger knew Wink had never extended credit to anyone. The shining knights were just stumbling over one another today.

Rebecca had an upset stomach, common for those new to shifting gravity fields. After she returned from the infirmary, Roger helped her rent a suit. He noticed how confidently she snapped the limb segments onto the torso.

"You've done this before?" he asked.

"I practiced during the trip from Earth."

He gave her credit for effort, and points for not commenting on the flivver's condition, which looked the same after Wink's servicing as before. The retro pedal was still sticky, too. Roger wondered what Wink would charge him for.

They jetted into a higher orbit. Soon, while transiting the interior plain of Piazzi Crater, they observed a twin sunrise.

"Solar mirror?" she asked.

"Yep. The Piazzi Concentrator."

"It looks huge."

"Ten klicks."

"Ten square kilometers?"

"Ten klicks diameter. About eighty square."

"How much thermal power is that?"

"Around Ceres, solar intensity is roughly a gigawatt per square klick."

"Eighty gigawatts?"

"Yep."

"That's incredible! Back home, Austin has been trying to get permits to build a one-gigawatt nuclear plant for years now! And here you just float some tin foil!"

"Well, actually, it's aluminum-coated Mylar, weighs over a thousand tons, and maneuvers with minirockets. But yeah, power's cheap out here. Your family lives in Austin?"

"Just myself, these days."

In the midst of Piazzi's bowl, a third sun glowed orange, then white-hot. They lowered their visors.

"Smelting by concentrated sunlight?" she asked.

"About a quarter million tons."

Her helmet shook. "You couldn't do that scale on Earth."

"I suppose not. Environmental impact statements and all."

A habitat wheel revolved above the mirror's backside. The flivver's docking ring looped a rim hook. They climbed into a foyer. Cameras scanned. Grady greeted them inside.

"A woman," Grady said as they lifted helmets. "I thought they quit making those."

"Cut the cute," Roger said. "She's my client."

"Hokay. Roger, I owe you, but be discreet. Even if you were still Company, accessing the human resources data base for personal use is *verbot*."

Grady led them through a deserted office area to a cubicle. He plopped in front of the workstation. "Keep a lookout," he said, plugging passwords into screen windows.

Roger scanned the partition tops. Presently, Grady announced, "Forty-three employees with Thomas in their names."

"We're assuming he worked for Ceres Mining," Rebecca said.

"Everyone around Ceres has," Grady said. "No sane person pays their own way out here. They sign with CM and the company covers the ticket."

"I paid my own way," Rebecca said.

Grady pretended to be fully absorbed by the screen.

"Rebecca," Roger said. "You recognize any names?"

"No."

"Would it help to view photos?"

"No. Hmm. Instead of Tom, try Huck."

"Huck?" Grady asked.

"H-U-C-K. My father said if Tom didn't come, Huck would."

Grady checked. "No Hucks."

Huck, Roger mulled. Then inspiration: "I take it your father was out here, too, and that's how he met Tom and Huck."

"Yes. So?"

"What's your father's name?"

"Alberto. Why?"

"Grady. Try Alberto Sanchez."

The screen reported Alberto Sanchez, Service April 16, 2037 to May 5, 2039.

"I didn't know he worked for Ceres Mining," Rebecca said.

"The Assignment field says he was a mixer," Roger said. "Unusual."

"A mixer?"

"Slang for nanotechnician."

"Oh, yes. He was a nanotech."

"Let's see if we can find any other mixers who worked with Alberto Sanchez around the same time. Maybe they know something about Tom or Huck."

The query shuffled employees, filtering all but five. All were hired and terminated on the same dates as Alberto Sanchez. The Contact field stated EARTH RETURN for three, LOCATION-UNKNOWN for the fourth. And the fifth:

"Melvin Barrow," Grady read. "Ceres coordinates."

Roger calculated. The man dwelt in the depths of Obarator Rift.

The flivver dove into the main shaft. Painted numerals on the walls announced depths in hundred-meter units. At the seventy level, Roger consulted the laser-gyro and streaked into an S-curving gallery. They were so deep inside Ceres that the atmosphere had thickened enough to support pockets of mist, which reflected the headlight beam with a series of milky veils.

"You're heading in circles," Rebecca said after several minutes of branching tunnels.

"More like a spiral." He tapped a glove against the gyro. "These numbers are our three-dimensional coordinates—longitude, latitude, altitude/depth. I'm matching them to Grady's report."

"So you don't know your way around?"

"These tunnels closed before my time."

"I noticed the lack of traffic." Her hand touched the clasp on her handbag.

The tunnel widened into a cavern whose walls vanished into the gloom beyond the headlamp beam. Light gleamed off cylinders so tall that roof stalactites had been broken off in accommodation. Roger landed in a deserted parking lot.

"It's like a lost city," Rebecca said, gaping at the avenues of towers.

"A mixing facility," Roger said. "Those are nanojuice tanks, I know that much."

Plucking the gyro from its dashboard mount, Roger left the flivver and tracked the coordinates to a side passage, where a flatbed car rested on rail tracks. They gripped the siding and Roger pressed the panel button. The car lurched down the track, into a bend.

"You have any idea where you're going?" Rebecca asked.

"Not since leaving Earth." In the silence: "Sorry. Old joke."

The track tilted sideways. The car hit a hundred KPH, looping the curving passage. Centripetal force, Roger judged, mimicked Mars surface gee.

They merged into a wider tunnel. A train of huts rolled on parallel tracks. Their car automatically docked with the rear porch. Roger pressed the airlock buzzer.

"Don't often have visitors," Melvin Barrow said after introductions had been exchanged. He wore a rumpled corduroy shirt and looked to be late middle-aged, about eighty or so. "Come on in. And call me Mel."

Rebecca and Roger took opposite ends of the sofa. The chocolate-colored Labrador sniffed, then drooped its jowls onto the throw rug. Mel muted the TV.

"Little Becky Sanchez," he said. "Must have seen a dozen vids of your childhood. Now you're all grown."

Her complexion wasn't dark enough to conceal the blush. "So, Mel, how well did you know my father?"

"Enough to tolerate his wine. But I only met him here after the Jersey Goo, 'course."

"You mean the New Jersey Nanoindustrial Release Incident," Roger said.

"Well, the media circus called it the 'Jersey Goo.' God, the nonsense! A cupful of molecular-separation nanojuice leaks from one recycling plant, and there's a tri-state evacuation! And the lawsuits! Every circuit card that malfunctioned on the Eastern Seaboard was grounds for a class action settlement! Course it was overreaction, but tell that to the public."

"My father mentioned it," Rebecca said. "It was why he had to leave Earth."

"The whole molecular-separation industry was driven off Earth because of liability and regulatory costs. We nanotechies had to follow."

"But I saw that smelting mirror in orbit here. How could you compete with something that size?"

Rebecca was taking her time, Roger noticed, in getting to the business of finding Tom or Huck.

"Politics," Mel replied. "The nanotech lobby demanded subsidies. They got 'em 'til Congress decided the cost-vote ratio was too high. Then we were shut down."

"Then you joined Ceres Mining," Rebecca said.

"Yep, they had nanotech projects too. Marginal, experimental affairs. Then they let us go. And then us nanotechies learned the government had abandoned the facility here. Someone stripped the parts for black market. Me, I set up house here in the old control center. No plans to return Earthside. Got no money, no family."

Curiosity getting the better of him, Roger asked, "And Rebecca's father?"

"Alberto was different. His ex-wife died, and he went Earthside to care for you, Becky. But I heard he got arrested right off the shuttle."

"For stealing public property," she said. "From this place here, I suppose."

"Becky, your father didn't take a gram of equipment. Only took the residual juice from the tanks. Which was about to denature soon, anyway. Hardly worth a penny. Can't see any fuss over that."

"He took nanojuice," Roger said, perking. And as if he didn't suspect: "What for?"

"Alberto planned a molecular extraction operation of his own. Wasn't that crazy. The juice was already brewed. And some places on Ceres, the rock's so porous that all you have to do is sprinkle the juice and the platinum oozes right out."

Roger asked: "How big an operation?"

Rebecca glanced sharply. Mel shrugged.

"Hard to say. Problem is, the process is snail-slow unless you have catalytic boosters, which we lack the infrastructure to fabricate here. Given the diffusion rates, Alberto probably went home before the first kilo was leached. Sorry, Becky."

"But he told me," Rebecca said, "contact Tom or Huck, and they would give me the platinum!"

"Never heard Alberto mention any Tom or Huck, outside of his discourses on Mark Twain."

"Twain," Roger said, wrinkling his forehead. "What does—"

The sentence died on his tongue. Rebecca was glaring.

"How's your father these days?" Mel asked. "Did he ever go back to graduate school?"

"No," Rebecca said quietly. "He's . . . okay."

The Labrador on the rug, aware of the discomfort, did an eye-dance of darting glances. Rebecca abruptly arose, fidgeting with her helmet.

"Thank you," she said. "Guess I'll find the mine somehow."

"The mine?" Mel snorted again. "That what you're looking for?"

"You know where it is?"

"Your father wanted me to partner, took me there once. I'll give you directions."

Helmets reaffixed, they returned to the sunlit surface world. While Roger refueled at the hyox station on the threshold of the Rift, Rebecca handed over ten Bank of Ceres notes.

"I hope this covers it," she said crisply. "Thanks for your help."

The bills were about half of what he'd normally earn in an afternoon. He returned two and said, "How are you going to find the mine? By yourself?"

She gave a nervous glance toward the other pumps. Voices carried far, over space suit transceivers.

"I'll manage."

She started walking toward the Ceres Transit stop.

"I'm sorry," he called.

She turned back. "For what?"

"You know. Grabbing control of the conversation with Mel. I should know better. But I'd like to help."

She grimaced. "Lately, people have been entirely too helpful."

"Well, I realize I'm an unknown quantity, but so is everyone else here. And you still need help."

"I don't have money—and I don't want charity. I'm old enough to know that when a guy offers something for free in the beginning, he usually demands a certain kind of payment in the end."

"I understand. We'll keep this professional. How about . . . ten percent finder's fee?"

"Five. And you'll do more than drive."

Roger didn't want to seem a pushover, but her expression said not to haggle.

The hydrogen and oxygen pumps blinked shut-off. Roger and Rebecca buckled into the flivver. As the vehicle arched over the mesas of Ferdinandea, Rebecca studied the driving directions Mel had transmitted to her computer tablet.

"'South of the catapult,'" she read. "He means, the electromagnetic catapult that launches shipments to Earth?"

"No doubt," Roger replied, veering south. They overflew a straight line that ran for kilometers, its evenly spaced lights glowing bright against the low albedo of the natural rock.

"Next. Proserpina Highlands and Palermo Crater."

Roger knew the highlands, and soon the flivver was bounding over the spires of the Aventine Mountains. But then came the uninhabited wastes of the Ceresian Outback, mottled with ice-bottomed craters whose names had been forgotten even by the planetologists who had christened them early in the century.

"Palermo," Roger muttered, plugging the gyro into his computer tablet's atlas.

"You're lost?"

"I know where we are, give or take a hemisphere."

"Roger . . . assuming we find it, do you think I can operate my father's mine successfully?"

Roger took a moment to absorb her first-time use of his name. "Well, for years, there's been an economic tug of war between asteroid miners and Earthside nanotechnologists. The nanotechies claimed it wasn't competitive to mine in space, because molecular separation was far less energy intensive. But energy costs are almost negligible here."

"You get it all from solar power."

"Yeah, even the EM catapult is solar-powered. As a result, molecular separation hasn't been competitive for a while."

"But Mel said all you'd have to do to get platinum out of the mine was spray on the nanojuice."

"That's cost-effective with free nanojuice. But nanojuice usually requires an army of Ph.D.s to oversee the synthesis process. It's not cheap. And the juice your father took would have spoiled years ago."

She had faced him while he watched the horizon for signs of Palermo's rim. Now she turned forward and shifted in her seat.

Finally, he broke the silence: "Mel mentioned your father and Mark Twain. What's that about?"

She half smirked. "Do you know who Mark Twain is?"

"Famous American author, twentieth century."

"More, nineteenth. It has to do with my father wanting to teach early U.S. Literature. Nanotech was just to put food on the table."

"I know how that works."

"Anyway, dad was really into Mark Twain. He read *Tom Sawyer* to me when I was five years old. And I suspect I'm named after Becky Thatcher, Tom's girlfriend." Her teeth flashed an unexpectedly broad grin. "Which I don't appreciate, since she's a stereotypical Southern Belle. Very emotional, very fragile." Rebecca stared skyward. "Couldn't last long here, that's for sure."

"*Tom Sawyer*. That's one of Twain's novels, right?"

"*The Adventures of Tom Sawyer* is his most famous."

"Wasn't there another character, Huck Something?"

"Huckleberry Finn. Tom's best friend."

"Tom and Huck. Rebecca, the coincidence troubles me."

"You mean, my father the Twain fanatic, meeting a Tom and Huck in real life."

"Did you ask him about that?"

"I . . . wasn't able to."

The crosshairs flashed on the computer map. Roger descended toward a rubble-strewn crater bed.

Mindful of fuel, Roger swooped over the plain of Palermo Crater. It was stuccoed with boulders and rocks, the debris ejected from the impacts that had formed neighboring craters. In the center, a mound rose in pinnacles like the towers of a fantasy castle.

Passing over the cliffs of the rim, his headlight beam shifted shadows. Every cleft yielded a wall of rock and frost, but never a deeper recess.

"Where's the mine?" Rebecca asked. "Mel said we couldn't miss it."

Roger saw a glint as bright as Jupiter, beneath the crater rim. On approach, he realized it was his flivver's own beam, reflected by the window of a shack. Spotting a flat clearing on the crater floor, he landed.

Rebecca bounded out. Her first jumps were unsure and wild, but she soon mastered the knack of twitching her feet to mimic a normal stride in Ceres gravity. Roger hopped over. She gazed to the east. Translucent pillars of predawn light streamed from the rim.

"Dust," he said. "Electrostatically levitated by solar wind."

"It's beautiful, in its own way."

The shack lay nestled between cliff protrusions that Roger judged, by the angle of the celestial pole, would shield from solar flares during the daytime hours.

"The airlock is open," she said.

"Meaning it's abandoned."

Their boots trod upon smooth dust. Inside the lock, their helmet beams played over a bare desk, a fold-up chair, wall hooks where a hammock might have hung—and, in the corner, a winepress, filtration device, and fermentation vat. Boxes, mechanical parts, and electrical components lay scattered across the floor.

Rebecca slipped around the desk. Against the far wall, the floor glittered in her helmet lamplight like a field of diamonds. She picked up a fragment of glass. It was part of a bottle, Roger saw, like the one she'd had on the table at Wink's bar.

"He wasn't a heavy drinker," she said. "He never smashed things."

"Rebecca, he lost his job and was alone for a long time—"

"He's not like that!"

Feeling the rage in her voice, Roger looked away. His eyes rested on the smooth ground outside the shack. He frowned.

"Maybe you're right."

She joined him outside and watched him scrutinize the dust.

"Just your footprints and mine," he said. "Yet your father must have walked here a hundred times."

"That's right! There's no wind to blow the tracks away. So where are they?"

"Offhand guess? Somebody came after your father left. They searched the shack, knocked everything over. Then they swept the prints to cover their tracks. Which, unfortunately, also conceals the path to the mine."

"But it's got to be nearby."

"Yeah."

They bounced—three meters at a time—down the incline to the edge of the clearing where the flivver rested. While Roger examined the surrounding rocks, Rebecca held her computer tablet skyward.

"I'm linked to the comsat, but all I get is a call tone," she said after a few minutes. "Maybe the signal isn't penetrating the cave."

"His TV worked. He's tapped into the Rift's communications spine."

"Mel, answer!"

Roger halted and crouched. A few grains of dust, barely visible—but yes!

He straightened and saw her in profile. Unaware that he was watching, she had let her guard down. As she gazed at the untwinkling stars, she looked both lovely and bewildered.

"Rebecca."

She slowly faced him.

"I realize I'm only a stranger," he said, "but I'd like to know what I'm getting into. I saw how you reacted when Mel asked about your father. Is there a reason we can't contact your father and find out where the mine is?"

Silence ensued. Roger feared she might demand a return to Alphaville. But then she said, "Yes, there's a reason."

"Is he in prison?"

She paused. "Worse than prison."

"Is he—dead?"

"Maybe . . . worse."

"It might help if you told me."

"There's not much to tell." She added quietly: "He's in hypersleep."

"*Hypersleep*. Why?"

"Because the government regards theft of nanotechnology as a national security issue. Technically, dad is charged with treason."

"Just for taking platinum-extraction nanojuice that was past its shelf date?"

"He was accused of stealing a lot more than that. The charges were made anonymously, and I know they're false! But he's being held without trial. A prosecutor told me that my father doesn't deserve a trial, because traitors don't deserve trials. People on Earth think that way."

"But a trial is how you determine the truth! You can't automatically believe accusations!"

"I think they know they made a mistake. That's why they're holding him in hypersleep. If he was conscious, he could make legal appeals."

"Well, they can't keep him in hypersleep forever. There's risk of brain damage."

"I know. Five percent after five years, ten after six. It goes up fast." Her voice lowered. "This is year five."

"I'm . . . sorry." Roger felt his cheeks redden at the inadequacy of his words.

She raised moist-rimmed eyes. "I can't afford attorney fees. That's why I need this mine. But all I have is the text message he smuggled over the nurse's phone, just before they put him in. I thought it would be easy. Just, 'Go to Ceres, meet Tom.'"

His earphones transmitted her sniffing.

"Come here," he said. "Please."

When she had hobbled over, he pointed to the rocks edging the clearing.

"See?" he said. "The dust shook off your father's boots as he walked here."

Tracing the faint trickle, Roger pointed toward the central peaks.

For an hour they circuited the peaks. Roger thought of the walls of Jericho.

Above the cliffs, the pinnacles resembled minarets and accusing fingers. Earth gravity and weather erosion would not have tolerated such ungainly formations, but here they might endure eternally. They almost had, except over one pile of rubble on the far side. Which was where the dust path terminated.

"This isn't natural," Roger said.

Together, they heaved rocks off the pile. After minutes of mutual huffing, he realized it was too deep.

A hippopotamus-sized boulder occupied the center of the landslide. Climbing behind, Roger pushed with his legs. Rebecca helped. But even in Ceres gravity, some things are beyond human strength.

"We'll need explosives," Rebecca said.

"I've got better than explosives. I've got rocket fuel."

He soon had the flivver hovering over the landslide. The winches unwound and Rebecca wrapped the cables around the boulder, fastening the hooks tight. She retreated with a thumbs-up. He pushed the thrust lever to one ton, two tons . . . high enough to buck him unconscious should the cables snap.

The flivver's main thruster flame licked the rocks. Silently, the boulder levitated. With fuel critical, Roger dragged the boulder only a meter. He released the cables, relanded the flivver, and trotted back to the peak.

It took a moment for Roger's eyes to readjust from a scene lit by rocket glare to one lit by starlight and helmet lamps. Then he, too, saw the dark mouth, a gash barely wide enough for a grown man. He certainly wouldn't be flying the flivver through that.

Large white letters were scrawled above the entrance, in what Roger assumed was synthetic chalk. They read, simply: MCDOUGAL'S.

"Who's 'McDougal?'" Roger asked. "Should we be looking for him, too?"

"No," Rebecca said. "There's a cave in *The Adventures of Tom Sawyer*. It's owned by a man named McDougal."

Roger tilted his helmet. "So . . . you think this is your father's whimsy?"

"See how the letters lean? That's how he always wrote on my birthday cards."

"All right. Great. Then this it. Guess we'd better start, huh?"

He took a step. Rebecca, fixed in place, stared at the entrance. As the seconds stretched, Roger realized her lack of reply was a reply.

"You should stay outside," he said. "You can call for help if there's trouble."

"No, I'll come." Her breath was deep and fast, almost hyperventilating. "It's just that . . . nothing's ever affected me like *that*. Dozens of horror movies, and nothing's ever scared me as much as *that.*"

"What are you talking about?"

The labored sound of her breathing made him wonder if her suit was leaking.

"I told you," she said. "When I was five years old, my dad read *Tom Sawyer* to me. At the end, Tom and Becky are touring this cave—I mean, McDougal's cave—when they get lost. They wander for days and days and can't find the opening. Their candles go out and they almost die in the darkness. It's . . . the thing that scares me the most."

Roger shone the beam deep inside the hole. He didn't feel terrified, but he did feel enough unease to appreciate Rebecca's trepidation.

"We'll have to go a ways," he said. "Ceres is a carbonaceous chondrite asteroid. The metal deposits come from meteor impacts. They're buried deep, like raisins in pudding. If you've got claustrophobia—"

"I don't. I'm fine in buildings, spaceships, everything else. Even the Rift didn't bother me that much. But this . . ."

He groped for encouraging words, but then she stiffened.

"Well," she said huskily. "It's not as if we'll run into Injun Joe, is it? Let me get my handbag."

She returned from the flivver, bearing her handbag. His mouth was still open as she brushed him aside.

When he had squeezed meters within the gap, the telecom status bar on his helmet heads-up display vanished, signifying loss of contact with humanity. To Roger, it was more disconcerting than the silence of the vacuum or the darkness of the passage.

He took the lead. Stepping over boulders, they bent low as the roof and floor closed together. At the passage's neck, they got on their knees. Then it became even tighter, and they pulled their bodies with their hands. The constant flexing against suit linings made hard work.

After the bottleneck came a large cavern. Finger-thin stalactites and stalagmites jutted everywhere, many white as fangs from the frost. The needles were bent at midpoint, all at the same angle. Roger surmised that the floor and roof had drastically tilted over the eons. And for mineralized water to drip, the cavern must have been pressurized and warmer, once.

The ice-free wall ahead proclaimed: ALADDIN'S PALACE. Roger raised an eyebrow.

"It's definitely dad's writing," Rebecca said. "And the over descriptive, tourist-trappy name is right out of the cave in *Tom Sawyer.*"

Additional scrawlings designated the branches into other chambers: *AREA 1, AREA 2,* and *Crystalarium/FAC.*

"No crosses," Rebecca murmured.

"What?"

"Nothing."

Trying to make conversation: "Was there a 'Crystalarium' in Tom Sawyer's cave?"

"No. What does 'Fac' mean?"

"Facility. Ceres Mining-speak."

"So you worked at Ceres Mining, too."

"For a while."

"You don't strike me as the miner type."

"Which is?"

"Not that they're stupid. Just that they must have a high tolerance for boredom."

"And you think my tolerance is low?"

"The way you drive . . ."

"Let's keep moving. We've only got a couple hours of suit power."

They took the branch marked for the facility. Soon the passage widened into another cavern, where flakes of dust were drifting from the roof.

"Cave dandruff," she said.

Roger brushed a chip off a sleeve. "Probably a small tremor."

"Ceres is geologically active?"

"No. But it's in the middle of the Asteroid Belt, and it's always colliding with something. Settling aftershocks last decades, sometimes. The ice deposits have a high plasticity under pressure, too. So the ground is always shifting."

"That doesn't sound safe."

"Yes and no. I've flown through a cave-in, relatively unbruised."

"Low gravity makes it seem like slow

motion."

"Yeah. Course, you can still get crushed, if you just sit and watch."

The drizzle of dust continued. Ahead, across their path, the rocky floor had vanished beneath a carpet of dust. Roger extrapolated the roof-fall for millennia, perhaps eons.

"Stay here," he said. "Please."

He unzipped his pocket and extracted a spool. He wrapped the end of the line around a boulder, and unspooled the rest as he slowly trod over the dust. His footing felt firm—and then it didn't.

Roger saw her eyes widen. Then his helmet slipped beneath the surface of the dust pool. All became darkness.

He clutched the line and jerked to a halt. He started to pull, but then felt himself rising. His helmet broke surface.

Rebecca hoisted the line, hand over hand. She helped him onto solid ground.

"I think I saw an arrow pointing to a side path," she said.

"Let's try that."

He brushed himself off, and took the lead so that she wouldn't see the redness of his cheeks.

A few caverns farther came a pit. As Roger peered over the ledge, his helmet lamp beam flickered against vertical, smooth walls. He saw an opening about fifty meters below, but the beam faded before reaching the bottom of the pit. A deadly fall, even in Ceres gravity.

"I bet," Rebecca said, nodding toward the opening below, "that you never made a delivery to a place like that."

"You lose."

He unspooled the line. Tying the end around a stalagmite, he rappelled until even with the lower opening. He pushed off the wall and swung, pendulumlike, to the opposing ledge.

"You don't have to—" he started.

But she tugged on the line until he released. A moment later, she swung alongside.

"If you're trying to prove something," he said, "don't."

"I just want us to get there."

"We need to proceed with caution." He forced a grin. "On a frontier, a little fear can be a good thing."

"I can't allow myself to be afraid. I don't believe in fear."

From a height a head shorter than his own, she presented a steady gaze and a jutting chin. He almost averted his eyes, but then humiliation led to rage.

"That's a stupid thing to say!" he blurted. "And if you want to fire me for telling you that, fine. We'll go back to Alphaville and you can hire some fool who hasn't been out here a month—and the two of you can hop and skip hand in hand over the edge of the next pit, for all I care!"

She met his eyes with an expression that was set and firm yet somehow revealed nothing of her thoughts. She said nothing. Roger's anger, quick as it had come, mutated into shame.

"I'm sorry," he mumbled, lowering his gaze. "Maybe I just don't want to admit, I'm just a delivery driver. I have no experience as an explorer. Maybe you should get someone else."

A slight smile. "You've been doing fine, so far. I feel I can trust you—and that's what's really important to me now." She added quietly, "I think the only other man I've ever been able to trust is my father."

Roger cut the line and wrapped the free end around a rock. Rebecca followed him into the passage.

The Crystalarium needed no words in chalk.

The walls of the huge chamber shimmered with razor sharp crystal. Formations of white gypsum loomed with the proportions of grotesquely deformed human statues. Gargantuan chunks of quartz, transparent as ice cubes, transformed their helmet lamp beams into a dazzle of rainbow-fringed, splintered reflections.

They snapped off their lamps. Their

eyes grew accustomed to the dimness. Roger felt awe. The crystals glowed and sparked with enough light to distinguish silhouettes.

"Beautiful," Rebecca said.

No qualifier this time, Roger thought.

She reached for a luminescent projection. Roger blocked.

"Careful, there might be static buildup."

She indicated a pair of insulated cables running along the walls. "Those look like power lines."

"Good guess. If this vein reaches the surface, then it could receive a substantial charge from the solar wind during the day. It's far less efficient than solar cells, but the crystal is here and he didn't have to pay for it."

The cables snaked into a narrow passage. Leaving the crystalline formations behind, they turned on their helmet lamps again and entered a realm of ordinary rock, shorn of ice or frost.

Ahead, their beams shone on a rubble pile. Boots stuck out of the bottom.

"The size!" Rebecca exclaimed. "It's like a child!"

They scraped away the rocks. The body was metal encased. When Roger turned the figure over, he met camera lenses.

"A robot," he said.

The chest was half missing, the abdomen computer module shredded. Roger thought of a frenzied robokiller armed with a hatchet, but what hatchet could cleave metal like that?

Another pair of boots projected from the rubble farther down. Roger pulled the body out. The robot was identical to the first, a humanoid figure about the size of a twelve-year-old human. From rubble near the head, Roger extracted a straw hat.

"My dad's," Rebecca said.

On this robot, the back was ripped open. When Roger flipped the body over, he found a label on the chest.

TOM, it read.

"One mystery solved," he said. "The other must be Huck."

"No wonder they didn't meet me when I called."

Roger attempted to flex a broken shard of casing. "This is too much damage to have been done by a cave-in."

"Someone attacked them? Who?"

"Your father's coworkers were the only ones who knew about this mine."

She hugged her handbag. "Those cables there. They go to the facility?"

"Probably."

"Let's go."

"Well . . ."

"You're going to say, don't get my hopes up."

"Well, if the robots worked here for years after your father left, then they probably did accumulate a supply of platinum before the nanojuice went sour. But if someone's been here, chances are they took the platinum."

"I want to know."

They followed the cables.

The laser-ring gyro indicated that they had descended more than half a kilometer from the crater floor, and had traversed kilometers of winding, branching caverns.

Then the passage widened and leveled into an arena-sized chamber. Roger saw footprints in the dust, matching the boot sizes of robots and full-grown men. The cables plugged into a junction box, which distributed cords to storage tanks.

The tanks were spherical balloons suspended by threadlike cables from the roof the chamber, and utilized the environment's vacuum for thermal insulation just as did spacecraft for long-term storage of cryogenic fuel. They were small only in comparison to the towers in the cavern where Mel Barrow dwelt. Watching his distorted reflection in their mirrored surfaces, Roger felt like an ant wandering among marbles.

"Did he build all this himself?" Rebecca asked.

"It's actually pretty flimsy," Roger replied. He pressed a balloon and it jostled with liquid. "N2," he read the marking-pen scrawl. Liquid nitrogen was used extensively as a coolant and pressurizer in certain nanotech processes, he recalled.

He traced through the hoses and valves, and located the nanojuice tanks in the rear. PRECURSOR, read one label. STAGE ONE, read another. Portable applicators and collector equipment occupied a shelf. Roger demonstrated how the robots aimed the spray wand.

"First they foam the walls with the primary-extractor nanojuice," he said. "The nanomolecules secrete hydrochloric acid to cut microscopic capillaries into the wall. Then components of the nanomolecular structure distinguish between platinum and nonplatinum elements, procure the platinum, and transport it back to the rock facing."

"They sound like miniature robots."

"That's what nanojuice is. Molecular robots. Anyhow, eventually the nanojuice seeps out of the rock and the big robots—Tom and Huck, that is—scrape it off and bring it here for extraction and recycling."

"If the nanojuice can be recycled, then how come it goes—what did you say—sour?"

"The more sophisticated nanomolecules are similar to the molecular machinery within living cells. In a sense, they age and die."

"You know a lot about this. Did you work in nanotech?"

"When I was studying to become a mining engineer, I took a couple semesters on molecular extraction technology. My instructor thought it would replace traditional mining, like digital electronics replaced analog."

"Did you ever become a mining engineer?"

"It didn't work out."

"Why not?"

"I wanted to be in space. But the way the industry works, only robots and miners go into space. Engineers stay home and crunch survey data in supercomputer simulations."

"So how did you get out here?"

"I signed with CM as a miner."

"You gave up your career because you were bitten by the Exploration Bug."

"Well, being a miner means being stuck in a cave, so it's hardly a cure. And my delivery service isn't making ends meet. So I guess it's back to Earth, soon."

"You'd rather live on the frontier."

"Yeah."

"My father would understand."

"And you?"

Rebecca said nothing more as Roger groped amid the hoses. Finally he came to the last containment. Opening the side door, he frowned.

"We're missing the Stage Six converter," he said.

"What does that do?"

"At this point in the process, the platinum is in a pseudofluidic state, confined within carbon-bonded buckyballs suspended within a graphite lubricant. The converter unlocks the buckyballs and releases the platinum in particulate form."

"In plain English . . . ?"

"A pseudofluid is like a very fine, slick powder that can be poured and pumped, and—well, long story short, this is where the platinum comes out." The floor underneath glittered in his lamplight. "Platinum dust. So the system was working. For a while."

They searched the remainder of the cavern. They found not a speckle more of platinum.

"I'm sorry," he said. "Whoever was here made a clean sweep."

Her eyes were unwilling to meet his.

"It's all been a waste," she said, kicking the dull gray dust.

Following the chalk arrows in reverse, they passed through the Crystalarium, climbed the pit, and side routed the dust pool.

"I'm sorry," she said at last. "I've wasted your time."

"You don't have to apologize."

"I can't pay you now. I will, though."

She was leading and he couldn't see her expression, but he sensed the discouragement in her voice. The Belt was always a rough place, but this had to be especially hard on someone so young.

"As I recall," he said, "my payment was five percent. Five percent of nothing is nothing. You're paid in full."

His grin faded when she didn't answer.

They entered into the grove of rock needles. She paused and gazed at the jointed stalks. Then she faced the legend scribbled in chalk on the wall.

"'Aladdin's Palace,'" she read. "Right out of the book. Which tells you all you need to know about dad's problem and mine. We expect life to match fantasy. But there's no buried treasure here."

"Was there one in Tom Sawyer's cave?"

"Tom Sawyer!" she said, as if spitting.

Roger felt as if the vacuum were echoing the silence. Finally, he said, "You know, you traveled millions of kilometers. You can't just turn back."

"Of course not. I don't have money for a return trip."

"Grady can help you get a job with CM."

"Work as a miner? That won't make enough to help my father."

"We'll come back here and search some more, all right? You won't give up without a fight, will you?"

She swung around and met his eyes. In her gaze, it seemed, a fire had been kindled with that one remark.

"No," she said. "That's what Becky Thatcher would do. Weep and moan and say something insipid like, 'I do declare that we are doomed without any hope of respite whatsoever!'"

He chuckled at her squeaky caricature.

"You said she was Tom Sawyer's girlfriend. He was attracted to *that?"*

"In the nineteenth century, men liked their women as delicate flowers."

"Well, in this century, we like our women strong. Not disagreeable, mind you, but a little backbone is appreciated!"

She struggled, but a grin at last curled her lips. "All right." She allowed Roger to come alongside, and they walked together. He was still working up the courage to ask her to dinner when she said, "To answer your question. Yes. There was a treasure in Tom Sawyer's cave. It was hidden by the villain, Injun Joe, and Tom and Huck discovered it."

"Injun Joe?"

"Twain was commenting on the racial attitudes of the times. Injun Joe was simply a product of societal rejection and . . . ." She saw the glaze on his face. "Sorry. I guess there's a little of the literature teacher in me, too."

"The treasure. How'd they find it?"

"It was buried under what Twain called 'the mystic symbol' of a cross, that Injun Joe had drawn on the wall. And don't bother looking. The moment we came down here and I saw the first chalk marks, I've looked for a cross."

"Well, I can't recall any—"

With a chill, Roger felt the rocks behind him crying out. He whirled and stared at the writing in chalk.

AREA 1. AREA 2. Crystalarium/FAC.

"'Crystalarium,'" he said.

"What about it?"

"It's the only word not in capital letters."

"So?"

"The 't.'"

"Oh God! Dad's sense of humor!"

They pounced upon the rubble beneath the fifth letter. There was no sign of treasure at first, but Roger was ready to dig to the core of the small world, if necessary.

He was too engrossed to notice the brief tremor.

Black sky and parched landscape had never looked so cheerful as Roger descended from the cave mouth and plopped the chest onto the crater plain.

"Too heavy for regolith, that's for sure."

Rebecca twisted the padlock. "I don't have a key."

"I'll get my cutters."

Roger rounded the cliffs. His heart gushed, and it was hard to keep from jumping like a jackrabbit.

He expected to find his flivver parked in the clearing. In the vehicle's place, however, was a crater he didn't remember. Nearby rested a charred tangle of metal. It took a moment for the causal relationship to sink in.

He sprinted back to the cave entrance. Rebecca and the treasure chest were still there. A few meters away stood a figure garbed in a bulky space suit. The gloves of the suit clenched a rifle.

"Stand next to her!" a voice growled in Roger's earphones.

The rifle was a late-model Kleister, popular with the local constabulary. Eying the bulging clip of explosive-tipped, rocket-propelled shells, Roger sidestepped over to Rebecca.

A hand lifted a helmet visor. Mel Barrow smirked at Roger.

"You're betraying my father!" Rebecca said. "He offered you a partnership!"

"That was a lie, Little Becky," Mel said. "Your father kept this mine a secret. I found out where it was on my own."

"How?"

"Saw a robot in Alphaville one day, wearing a straw hat, loading wine bottles into a storage unit. Had 'Tom' on its nameplate. Not too hard to connect to Alberto. So I followed it here."

Rebecca's expression hardened. "And you were the one who got my father arrested, weren't you?"

"Becky, really. Why would I do that?"

"To keep the government from investigating you. You stole the equipment from the government nanotech facility, and then you accused my father of the crime!"

"Becky, I was too late. Someone stripped the place clean before I got there. Think I'd live in that hole if I had any money? All I found was Engine Joe."

"Engine Joe?" Roger asked.

Mel chuckled. "Alberto would appreciate my humor more than you will."

He pointed a remote control toward the cliffs. Something stirred in the shadows. Roger felt cold and breathless.

A dirty ovoid, towering three meters tall, emerged upon spiderlike legs, tentacles whipping.

"Class One Autonomous Excavator," Roger said slowly, finding it hard to enunciate through numb lips and a suddenly dry mouth.

"Reprogrammed as my watchdog," Mel replied. "Not too bright, though. Tore apart poor Tom and Huck before I could download their memories. Now, move from the chest, or he might get excited again."

Roger and Rebecca retreated from the chest. Mel aimed the remote, and the excavator bowed toward the padlock. Out of its head grew spikes that looked capable of slicing and dicing a Kodiak bear. The spikes twirled into a blur. The padlock fell with a cascade of sparks.

"Mel," Roger said. "Let Rebecca keep a share. Her father needs—"

"Ever hear the story of the djinn imprisoned in a bottle for two thousand years?" Mel's eyes held pinhead pupils above an ear-to-ear grin. "First thousand years. Swears he'll grant every wish of the person who frees him. Second thousand, swears he'll kill the person for taking so long. Get the picture? I've spent too many years buried alive in a frozen pit, searching for that treasure!"

"You can't blame Rebecca for your own—"

"Open it!"

Roger lifted the lid. He backed away at a gesture from Mel's rifle.

Mel stared into the chest. A deep scowl creased his face, from contorted mouth to pulsing temples.

"What kind of joke is this?"

He yanked out one of the bottles and threw it hard. Blobs of inky black exploded and flowed in rivulets against the cliffside. The sight transfixed Roger, until he noticed Mel's glare upon him.

"Think this is funny?"

Mel thumbed the remote. Engine Joe's lenses trained on Roger.

"Please!" Rebecca cried. "We don't know where the platinum is!"

Mel, Roger realized, wasn't looking in the right direction—or the mixer would have known. Roger saw no reason to enlighten him. The rage in Mel's face said that even with the treasure, he wouldn't allow them to live.

The excavator backed Roger into a cleft. Roger attempted a dodge. Tentacles slapped him center. Spinning spikes approached his helmet plate.

"Stop it!" Rebecca shouted.

Her hand dove into the handbag. She withdrew a pistol, a nine-millimeter automatic. Extending a shaking arm, she targeted Mel.

Mel guffawed. "Little girl, this suit is special. Armored against micrometeoroids. I don't know who sold you that Earth toy, but out here it's—"

Rebecca's gun flashed. The recoil slammed her backward. The slug struck Mel's shoulder. It glanced off his armor, but the momentum knocked him from his feet.

Roger jumped, somersaulting over the excavator's head. Rebecca emptied her ammo clip. Mel stopped flinching. He had dropped the remote but still held his rifle.

Grabbing Rebecca's arm, Roger sprinted into the cave mouth just as a new crater pocked the cliff wall.

Roger ran so fast, his body forgot gravity. His boots recoiled off the walls, bouncing from the sides, his legs never giving Ceres opportunity to pull him floorward. Rebecca, despite her newness to minigravity, kept pace.

They reached the bottleneck. Unmindful of pain, Roger wormed through as fast as he could, pushing Rebecca ahead. She didn't protest.

Behind them, the excavator halted at the choke point. Then the spikes spun and rapidly chewed into the soft, congealed rubble that composed most of Ceres this close to the surface. In seconds, the machine widened the gap sufficiently to allow the skirt of its midsection to pass.

In the widening passage, they outdistanced their pursuer—for regardless of how Mel had programmed its brain, on the outside it was still an excavator. Its designers hadn't built for speed, for rocks didn't run away. But Roger knew the living could only run so far, and then they would be cornered.

They burst into Aladdin's Palace. Roger swung from branch to branch, paralyzed with indecision. Then he bolted straight ahead.

"The dust!" Rebecca cried.

"I know!"

He saw the dust pool and doubled his speed and leaped. Momentum sailed him a score of meters. He smacked onto solid ground. Rebecca landed alongside.

Scrambling behind a boulder, they scrunched and extinguished helmet lamps. Roger felt rivulets of sweat trickling down his face as he stared into the darkness.

Soon a pale glow lit the walls. A glimpse portrayed the lamps of the excavator as ghoulish eyes. The machine was an arachnid in silhouette, gliding on legs too slender to have supported its weight in Earth gravity. But they were not on Earth.

Sensing the human presence, the machine approached the edge of the pool. Tentacles probed the surface. The excavator trundled forward. The pool swallowed it like a gulped morsel.

Absolute darkness reigned. Roger flipped on his lamp. On the surface of the pool, a ripple faded. Rebecca's eyes reflected his hope.

Then the surface roiled and a tentacle snapped like an anteater's tongue and grabbed a stalagmite. The excavator broke the surface and flopped onto solid rock.

Roger slapped Rebecca's shoulder. They fled into the descending passage.

The floor abruptly came to the vertical drop-off. Roger's lamp surveyed the seemingly bottomless pit. He turned. All too near, the ghoul's eyes jogged.

Rebecca reloaded an ammo clip. Roger grabbed the gun. While she slithered down the line, he pumped bullets. The slugs ricocheted off steel limbs and plexiglass sensor covers and gouged into the soft cave walls. Roger retreated to the pit, judged the drop, and leaped.

In Ceres gravity, a fall of fifty meters is like a meter and a quarter on Earth. But gravity also conspired against him. Crucial seconds passed while he drifted. The excavator arrived at the upper ledge. Eyestalks tracked his descent. The computer brain made a split-second calculation. Legs and tentacles pushing for added velocity, the ovoid lunged.

Roger smacked inside the mouth of the lower passage and rolled. Rebecca dragged him from the tentacles as the excavator anchored itself and clambered over the ledge.

Exhausted, they raced into the Crystalarium. They doused their helmet lamps. Rebecca's silhouette arm motioned to a gypsum outcropping. They hid. The faint sparking of the crystal was overwhelmed by the glare of the excavator's lamps.

Roger watched the machine's fractured reflection in a sheet of quartz. The excavator swayed its camera stalks back and forth, in imitation of human indecisiveness. Perhaps the electrical discharges, Roger thought, were degrading its sensors.

The machine made a methodical search, poking tentacles behind outcroppings and into crevices. Conforming to the contours of the concealing rocks, the humans slunk from the cavern, into the passage that led to the nanotech facility and the end of their escape route.

Dodging the liquid nitrogen tank, Roger flew to the shelves of the facility cavern and picked up a nanojuice applicator—hose and wand and fluid drum—and carried it to the Stage One tank. He pulled off end caps and connected fittings. He twisted a valve. The balloon tank jiggled as the fluid silently enacted the motions of gurgling.

"You said the nanojuice won't work anymore," Rebecca said.

"It's too senile now to fetch platinum," he replied. "But as it ages, it actually gets nastier—more acidic."

She watched the level indicator. "Like wine, fermenting into vinegar?"

"Yeah. Hydrochloric acid is the first component to detach from the molecular machinery."

The fluid was syrupy. In one-fortieth earthgrav, it flowed into the applicator drum far more slowly than he remembered from a college lab demonstration a decade earlier—which was his most recent experience with nanotechnology.

Rebecca staggered from the passage. "It's coming!"

Only a few liters sloshed in the applicator drum, but Roger broke the fittings. Slinging the applicator strap over his shoulder and working the hand pump, he strode past Rebecca.

The excavator was glowing eyes, a looming shadow, then tentacles swiping at his throat. The machine bowed, spun its crown of spikes, parted its jaws, and charged.

Roger leaped aside. He aimed the wand and squeezed the trigger. A spray of foam caught the excavator in the face. The machine crashed into a boulder, spikes hurling a cloud of rock. It reared. Foam lathered its entire front. Roger thought of a rabid bull.

He had no time to think more. The machine advanced, brandishing tentacles, forcing him to the Crystalarium.

The tentacles extended their full

length and probed the walls—right, left, up and down, flicking too fast to allow evasion. Slowly, Roger retreated toward the pit.

At the ledge, Roger abandoned the applicator and climbed the line. The machine halted at the drop-off and elevated its stalks, tracking his progress.

But the lenses, Roger noticed, were caked with foam and dust, and etched with acid. How could the machine see?

That instant, he realized: *it couldn't*. But it had memorized the cavern layout, and could reason where he was—

Roger yanked and released the line just as a tentacle slashed at exactly where he would have been had he kept climbing. His impulse flung him against the pit wall. He shoved with a leg and flew to the other side. He pushed again. The perpendicular sides of the pit offered no handholds, but so long as he kept bounding from one side to another, he could keep from falling. But fatigue was winning . . .

Roger jumped at the machine's head and grabbed a swiping tentacle. Striking the wall, he shoved off with all his strength. At the other end of the tentacle, the machine teetered.

It seemed to regain balance. Then Rebecca tackled from behind.

The excavator stumbled over the ledge and into the pit. Prioritized with self-preservation, it released Roger and clawed its tentacle tips into the wall. But the wall material was too soft to support the weight and the tentacles only scraped furrows as the machine plummeted.

Roger clung to Rebecca's hand. Two wall pushes later, they flopped onto the ledge. Hundreds of meters below, the excavator's lights shrank into faint stars.

"Can it climb back?" Rebecca asked, gulping breath.

"It needs to jump, like we did," Roger replied. "Excavators aren't designed for jumping."

Kilometers below, a flash briefly lit a blanket of mist.

Rebecca touched his shoulder. "My suit power's at twenty-eight minutes."

Roger checked his own gage. "Twenty-five."

Less than half an hour, and their suit recirculators would stop refreshing their breathing air, and their suit thermal coils would cease to warm their bodies above the ambient temperature of a hundred degrees below zero centigrade. Then they would gasp and freeze, and end by envying Alberto Sanchez in hypersleep.

Roger decided not to look at his power gage anymore.

They entered Aladdin's Palace. Roger hefted a rock and handed another to Rebecca, along with her gun. They switched off their lamps and headed into the passage to the surface.

A light gleamed around the bend. Roger slipped to the corner and peered. He confronted the barrel of a rifle and reflexively dropped the rock in his hand.

"Someone will have to get his dog," he said softly.

From the ground, Mel Barrow's eyes gazed at the spot on the roof where his helmet lamp beam blazed a circle. Flecks of blood dabbed his lips. Black crystals ringed the fist-sized hole in his abdomen.

"Explosive bullet," Roger said. "Probably shot in the back."

He wasn't sure about that, but neither was he going to turn over the body to make sure. Rebecca stood at a distance and looked elsewhere. Roger pried away the rifle. Cradling the weapon, he advanced toward the cave mouth.

"Whoever shot him, they're still—" Rebecca began. "Well, we don't have a choice, do we?"

"I think it's just one person," Roger said. "You take the rifle, I'll draw his fire. Then you shoot him. Can you do that?"

"*I'll* draw his fire. I'm a smaller target and you're probably a better shot."

"Now, look—"

But no matter that he raised his voice,

her expression remained unmoved. Not that he really wanted to do it his way—

They passed through the excavator-widened bottleneck. Rebecca gasped at the unanticipated darkness. Roger flipped on his helmet lamp and stopped worrying about who would leave the cave first.

He faced the mouth, but instead of the outer world, they saw rock—like the haunch of a hippopotamus pressed against the only known exit.

"Stand back," he said.

He took several steps back himself, and fired. The rocket-propelled shell's exhaust gasses whumped and whooshed against his helmet. A sliver of light streaked toward the boulder. The cavern flashed and the blast wave staggered him.

He glimpsed a shallow crater. Then dust blizzarded from the roof in clumps. Roger had seen the phenomenon once before—and that was too often.

"Run!" he shouted.

A pelting of rocks followed the dust, and then whole shards broke free. Roger and Rebecca scrambled. A dozen meters farther, the roof overhead showed no signs of further collapse.

Rebecca stared at the passage, now clogged with rocks.

"We're trapped," she said. "It's like—Tom and Becky—trapped in the cave!"

The pitch of her voice rose, a needle jabbed into his spinning mind.

"We're not them," he said. "They're only—"

"It's as if my whole life, I've been fated to—"

"Stop it!" he snapped.

She blinked.

He locked gazes and enunciated through half-clenched teeth: "Maybe believing in Fate is a luxury you can afford on Earth, but out here you've got to plan for every breath you take, and if every time you're in a tight spot you give up and complain about the unfairness of life—"

He didn't know how to end the speech, so he just puffed and balled his fists.

After a moment, she said: "It's getting to you too, isn't it?"

"Just don't cry. *Please*, because, uh . . . ."

Her eyes were too wise: *Because you might too?*

". . . We, uh, don't have time right now," he finished.

He took and released a deep breath. Finally, she looked away.

"All right," she said. "After all I've been through, I refuse to end like Becky Thatcher." Facing the blocked exit, she said, with overstressed casualness: "But how do we—?"

"Wish I knew." *How to be calm, especially*, he thought. After a moment's meditation: "I hope this isn't just idle curiosity, but since your father based so much stuff on Tom Sawyer . . . how did Tom Sawyer escape his cave?"

"He found another exit. But he searched for days. We've only got minutes."

He was still trying to think, when Rebecca uttered: "Bats."

Her eyes were steady, her face untrembling—the composure of perfect calm possessed by a person who is either at peace or gone mad.

"Bats?"

"Tom and Becky ran away from bats. That's how they got lost. When I was a kid, I always wondered, why didn't they just follow the bats out again?"

"Rebecca, there aren't any bats here. Just dead robots."

"And the nanojuice."

"So?"

"Well, they're like little robots, right? If some of them are still functioning, could you program them to seek a way out of the cave?"

"We don't have the equipment or expertise to—"

Then he thought about it.

With Mel's rifle in hand and Rebecca in tow, Roger returned to the threshold of the nanotech facility and aimed at the largest tank labeled "N2."

"What are you doing?" Rebecca demanded.

He nudged her into the passage. "You said we needed to program the nanobot molecules to find a way out of the cave. Well, in a gaseous state, all molecules naturally try to escape confinement. The scientific term is, 'leaking.'"

He pulled the trigger. The explosive shell ripped into the pressurized container. Liquid nitrogen instantly vaporized, filled the cavern, and rushed into the passage, bearing a miniature storm front of dust and ice particles.

"Follow the clouds!" he shouted.

They reached the ledge of the pit before Roger realized too late that there was a flaw in his plan. The pit was too vast a cavity. The expanding gas from the nitrogen tank was rushing not toward an upward passage, but into the chasm.

Roger fired at the passage roof near the ledge. The cavern's radically thickened atmosphere transmitted the impact as a muffled boom as the roof collapsed.

"You've sealed us in!"

"Now we go back. Look for any kind of eddy, any disturbance in the clouds!"

By then the gas was equalizing throughout the cavern complex. Dust was settling, and on the path back to the Crystalarium, Roger saw no particles drifting into the branching caverns. And beyond, Roger knew with a sinking heart, the passage to the facility was straight, short, and unbranching.

Rebecca knocked his arm. "There!"

In the tenuous atmosphere of the Crystalarium, all was still—except for a swirl of dust behind the gypsum outcropping where Rebecca pointed. Roger jumped over and pushed away a slab, revealing a hole—and a rope dangling within. The hole entered a shaft that was too consistent in diameter to be anything but artificial. Without a word, Roger pulled himself upward.

On Earth, an ascent of hundreds of meters was a daylong challenge of human endurance. On Ceres, their slight tuggings maintained a velocity that brought them to the surface in seconds.

The top opened into a room. Roger spotted the charging console and plugged in his suit and yes, there were active solar cells somewhere outside. And yes, dawn had come. The flashing red zero on his suit power reading faded as he took deep breaths and helped Rebecca plug in her suit.

"This looks like a basement to my father's shack."

He nodded toward a handle on the ceiling, in the corner. "That'll go topside."

"A trap door! How come we didn't see it before?"

Roger twisted the handle and pushed. The door had unexpected inertia. He slid it aside and hopped through the hole. In the upper room of the shack, the fermentation vat rested atop the trap door. The base of the vat concealed the seams of the door, Roger observed.

A glint caught his eye.

Beyond the window, in the clearing where Roger's flivver had once been parked, a figure in a spacesuit was loping from the central peak toward a newly landed vehicle. Upon the suit's backside was imprinted a skull-and-crossbones, and upon its shoulder the figure hefted the chest that Roger and Rebecca had unearthed.

As dawn's rays spilled over the crater rim, Roger aimed the rifle barrel at the hunched figure securing the chest to the vehicle.

"Hold it there, Wink!"

Hal Winkler swung around.

"Roger! Heh! What are you doing here?"

"You know what we're doing here. That's why you put a transponder in my flivver, isn't it?"

"Roger, please stop pointing that thing at me. We've known each other for—"

"Long enough to know you're no businessman. You were a mixer, like Mel and Alberto, weren't you? That's how you knew Rebecca Sanchez would lead you to the mine."

"I was a mixer? I'm sorry, is that a crime?"

Roger met the incredulous expression with an undiverted gaze.

"No," Roger said. "But you killed Mel—and then you sealed us in the mine just now. You tried to kill Rebecca and jump her claim."

"That's absurd!"

"Someone sealed the cave. You're the only person here."

"Your accusations are outlandish. The cops will never accept them!"

"They'll investigate one accusation. That you stole government property and framed Alberto Sanchez with your crime."

Wink's eyes shifted.

"The Ceres Mining human resources database lists one mixer as 'location-unknown,'" Roger continued. "The constabulary can procure the DNA sequence from the employee records. Maybe you've changed your appearance and name, but once they match your DNA, they'll investigate just where you got all that money to start your business. And then you'll enjoy a long rest in hyper—"

Wink roared and heaved the chest. Simultaneously, he drew an explosive-projectile gun. Roger dodged the chest and fired. A crater burst at Wink's feet, knocking weapon from hand.

Rebecca walked from behind Wink. Sprawled in the dust, Wink contemplated the sunlight gleaming off the muzzle of her gun.

"Your suit isn't armored, is it?" she asked.

"N-no."

"Then you're lucky that I'm a mature person, who can control her emotions."

Her kick sent him flying for meters.

A pair of Ceres Enforcement Service constables arrived shortly after Rebecca's call. Their interview with Roger was brief and professionally crisp. Their interview with Rebecca, to Roger's annoyance, was friendly and leisurely. Even more annoying to Roger was that, judging from her smile, Rebecca was coming to terms with the persuasive powers of being female in a female-starved society.

Wink's protests were ignored, and he was clapped into the CES cruiser, his vehicle keys turned over to Rebecca so that she and Roger could return to Alphaville at their own convenience. The constables departed with a promise to look in on Mel's dog. In fact, they needed a mascot and Rebecca could come visit at their HQ and . . . Roger had to practically herd them into the cruiser.

After their vehicle cleared the crater rim, Roger went over to the upturned chest and began reloading bottles. Rebecca came alongside and stooped. She picked up one of the cracked bottles. It dribbled its contents onto the dust, forming an inky puddle that glistened in the morning sunlight like polished slate.

"You know," Rebecca said, "I haven't a seen a single grape since coming here."

He knew where she was going with that, but kept his expression deadpan. "Ceres is the goddess of grain crops. Wheat, rye, barley. Not so much emphasis on grapes."

"I mean, this goop here—it's not wine, is it?"

"No." Roger squinted sunward, assuring himself that their recent visitors were out of communications sight. "Wine is like any other liquid, it vaporizes in a vacuum. That's pseudofluid."

"The converter was missing. . . ."

"Yeah. Your father must have instructed the robots to stockpile the pseudofluid in his spare wine bottles until he could install a Stage Six converter. Which we can do now, no problem."

"This pseudofluid. I think I drank some this morning. It's not toxic, is it?"

"No, it's just a transport medium. The

acid's filtered long before Stage Six. And the platinum's encapsulated, so it's safe too."

An odd light came to her eyes. "How much platinum does pseudofluid contain?"

"By mass? Oh—about twenty percent."

"Twenty—" Her jaw dropped. "The storage room in Alphaville! I've been in there! It's packed with these bottles!"

"Well, the robots had to store the extra stock somewhere. I would have picked a more unobtrusive place, but you know how robots are."

"*Roger*! How—how much—"

"Enough to enlist a legion of attorneys, I'm sure." His face could no longer stay straight. After he stopped laughing, he said: "When we get back to Alphaville, how about discussing this over dinner? I mean—if you'd like."

Rebecca beamed. "That sounds wonderful. And we can discuss anything else too. Except—I'm tired of Tom Sawyer."

"Well, you know, Rebecca, in a way, he may have had something to do with making you a stronger person."

"You can think that—but I've had enough of that brat for today!"

"I'm sure we can find other topics for conversation." His grin crinkled. "Perhaps something else Mark Twain wrote."

Her face turned pensive. "To be honest, I've never read anything else Mark Twain wrote."

Despite forsaking Twain, they were almost too absorbed talking over dinner to eat. ■

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Joe Schembrie

Joe Schembrie wrote his first science fiction story at age 9. But it took nearly forty more years for him to make the jump to full-time science fiction writer.

In the interim, he got an electrical engineering degree and an MBA. He also held a variety of jobs, including one at the Puget Sound Naval Shipyard, working on nuclear aircraft carriers and submarines, "crawling around reactor plants."

The work taught him a lot about how the military works ("It was a time when microprocessors were booming, but they were still using vacuum tubes") and about the rank-and-file mindset immediately after Vietnam.

"I don't tend to write stories about a rigid military hierarchy where everybody is gung ho about what they're doing," he says.

Every few years, he collected a new rejection slip from *Analog* editors dating back to John Campbell. "Then in my mid-forties I decided to get serious," he says. The result: seven sales since 2004, all to *Analog*.

In his writing, selling to *Analog* was always his primary target. Partly that was because, as a kid, he read a lot of science fiction anthologies, noting the *Analog* credits for the hard-science stories he most enjoyed. But he also likes *Analog*'s upbeat attitude. "[My characters] may not live happily ever after," he says, "but they do solve the problem of the day."

In general, he likes to focus on near-future stories. "It's hard science, so I don't do werewolves living in New York City," he says. "And usually it takes place off Earth." But so far, most of his stories (like the one in this issue) are set in the Solar System.

When writing a story, Schembrie asks himself two basic questions: *Is this fun to read?* And, *is this an adventure?* "I like a sense of motion," he says.

Overall, he believes in a positive future, though he admits there might be obstacles. "If there is one roadblock, it's human behavior," he says. "It may not be greed or selfishness or even hatred that stops us. It may simply be that we don't believe we can get to a better future."

His latest project: a young adult novel called *Rocket Ship Freedom* about teenagers helping a rocket scientist fly to the Moon. "Does it sound familiar?" he asks. "I kind of updated the Heinlein story [Rocket Ship Galileo] for the twenty-first century." ■

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COOLING OFF GLOBAL WARMING FROM SPACE

The reality of global warming is receiving growing acceptance. Even the Bush Administration seems to be modifying its previous hard-line position rejecting the idea. Projections of the Intergovernmental Panel on Climate Change indicate an average global temperature rise of between 1.5 and 4.5 degrees C by the year 2100. Climate change simulations suggest that we may be approaching (or may already have passed) a tipping point in global warming. Data records show a progressive increase in average temperature starting about 1920, with the average temperature of the Earth now about 1 degree C higher than it was in 1920.

There are predictions that fertile farmland—for example, in the Great Plains region of the USA—will be replaced by new deserts, that temperate zones will become more tropical, that the ecology of the ocean will be radically altered, that glaciers will melt, that the level of the ocean may rise by up to 20 feet, perhaps drowning costal cities around the world. Over the coming decades, the Earth may become a very different and less pleasant place.

Is there anything that can be done to avert this global calamity? Several technical fixes have been suggested. One of them is based on the cooling effects of volcanic eruptions. The progressive increase in average temperature over the past few decades shows a pronounced dip of a few tenths of a degree C spanning a decade that corresponds to the eruption of Mt. Pinatubo, a massive eruption that dumped many tons of sulfur into the upper atmosphere. It has been suggested that by putting 3 to 5 megatons per year of sulfur into the upper atmosphere on purpose, we could counteract the effects of global warming. This "cure," unlike an eruption event, would have to be done continuously for many decades. The side effects of such a remedy, however, appear to be as bad as the problem it is intended to fix. Acid rain from the sulfuric acid formed from the sulfur dioxide would become the standard kind of rainfall, irreversibly altering the ecology of the planet.

Professor Roger Angel of the University of Arizona, a prominent astronomer and creator of some of the world's largest telescope mirrors, has proposed an interesting alternative. He would like to place scatterers at the L_1 Lagrange point of the Earth-Sun system that would remove about 1.8% of the ambient sunlight.

To understand the proposal, let's start with what Lagrange points are. The Italian-French mathematician and mathematical physicist Joseph-Louis Lagrange (1736—1813), in attempting to solve the gravitational three body problem, discovered that in a simplified solar system in which the Earth orbits the Sun with no other planets or moons, there are five points of stability. They are now called "Lagrange points" and labeled L_1 through L_5. If a massive object is at one of these Lagrange points and displaced slightly in a particular direction, there may be a restoring force that pushes it back toward the stability point. The "Trojan" Lagrange points L_4 and L_5, which are in the Earth's orbit 60^0 ahead and behind the Earth, have such stability in all three directions in space. However, Lagrange points L_1, L_2, and L_3, which lie on the line through the centers of the Earth and Sun, are stable only in the two directions perpendicular to the line connecting the two gravitating bodies, but are unstable to "radial" displacements along that line.

L_3 is the "contra-Earth" Lagrange point on the far side of the Sun from the Earth. Its stability is more mathematical than real, because an object orbiting at L_3 would be strongly perturbed and soon kicked out of its orbit by the other inner planets of the solar system, particularly Venus. L_2 is the "Earth-shadowed" Lagrange point on the side of the Earth away from the Sun. The Wilkinson Microwave Anisotropy Probe (WMAP) is located at L_2, and it is also the location of the planned James Webb Space Telescope, to be launched in 2013.

The L_1 Lagrange point, about 1.5 million kilometers above the Earth in the direction of the Sun, could be called the "sunshine" Lagrange point. It is closer to the Sun than the Earth, but the "back-pull" of the Earth partially cancels the Sun's gravitational pull, so that it has the same orbital period as the Earth. It is stable to perturbations perpendicular to the Earth-Sun axis, but it is unstable to perturbations along that line, so that some active thrusters are occasionally required to maintain a satellite in this orbit. The Solar and Heliospheric Observatory (SOHO) and the Advanced Composition Explorer (ACE) are presently located at L_1.

Roger Angel's sunshield would be placed just beyond the L_1 point. Because the Earth and Sun have about the same density, the penumbra shadow of blocked sunlight from an object placed at L_1 almost precisely covers the disc of the Earth. Thus, it is the ideal location for an object blocking Earth-bound sunlight. Angel estimates that a reduction in the intensity of solar radiation by about 1.8% would full reverse the effects of a doubling of atmospheric CO_2.

However, in maintaining an orbit at L_1, the action of light-pressure is a problem. A square meter of radiation absorbing material (assumed to be 1.06 Om thick and to have an average density of 2.35 g/cm3) at the orbit of the Earth and perpendicular to the Earth-Sun axis receives a push from solar radiation of 4.6 ON (1 ON=10^6 newtons). The gravitational pull of the Sun on the same square meter of material is 15 ON, so light pressure would cancel about $^1/_3$ of the gravitational pull, and maintaining an orbit precisely at L_1 would be impossible.

Roger Angel's solution to this dilemma is to make several innovations. First, make the material *transmit* most of the light that strikes it and to scatter about 4% of the light at an angle of a few degrees, just large enough to miss the Earth but not large enough to absorb much momentum. The remaining light pressure still requires him to put the object in an orbit a bit closer to the Sun (about 1.8 million kilometers above the Earth) to achieve a stable L_1-type orbit. The downside of intercepting only 4% of the light is that you need 25 times more area than if you intercepted all of the light. As we'll see below, that raises the cost.

What goes into the L_1 orbit and how much will it cost? The cheapest solution would be to place a light-absorbing dust cloud there. However, light pressure and the radial instability of L_1 orbits would rapidly dissipate such a cloud. Therefore, one must instead use a "cloud" of autonomous sunshade spacecraft with "station-keeping" capabilities. Angel's sunshade spacecraft design is essentially a navigable sheet of silicon nitride containing holes with their centers placed 15 Om apart in a vast hexagonal planar array, so that light passing through the holes is coherently deflected in an interference pattern by a few degrees. Each unit has a mass of about a ton (1,000 kg) and has a shade area of about 2.4 square kilometers.

The total area that must be occupied by these sunshades is very large, about 4.7 million square kilometers. The total mass of the spacecraft needed to cover this area is estimated to be 20 million tons (2.0×10^{10} kg).

Angel is trying to get the launch cost down by suggesting the construction of an electromagnetic launcher, a "space cannon" mounted on a high mountaintop and having a "muzzle velocity" of 12.8 km/s. He describes a 2 km long magnetic coil launch system using peak magnetic fields of 24 tesla and requiring an energy input of 65 billion joules that is projected to provide such a capability.

Suppose it was decided that the effects of global warming must be mitigated in a 10-year period using this method. Angel estimates that with flyer payloads of 1000 kg each, about 20 million launches would be needed to deploy the sunshade system. He envisions 20 of the electromagnetic launchers, each costing about $30 billion, launching one flyer every 5 minutes for 10 years. A stretch-out to more decades of launch would require a smaller number of launchers operating for a longer period. The total capital cost of the launchers would be about $600 billion and the electrical energy cost about $150 billion. Added to that, the production cost of the flyers would be about $1 trillion. These figures do not include the development and operations costs, estimated to be less than $5 trillion. If the lifetime of the project is 50 years, than average annual cost would be $100 billion, about 0.2% of the world's gross domestic product.

Is this sunshade project, or one like it, likely to become a world priority and to be implemented? It's difficult to say. Concern about global warming is rising in all parts of a planet, but such concern would have to rise much higher to reach a level at which the megaproject envisioned by Roger Angel would be seriously undertaken. The resources of the planet have never been mobilized in a coherent way on such a massive scale, and it is not easy to visualize the political processes that might bring this about.

Nevertheless, it's an interesting idea, and it certainly has implications for science fiction, as well as geopolitics.

AV Columns Online: Electronic reprints of over 120 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available online at:
http://www.npl.washington.edu/av.

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Probability Zero

The Test

Kyle Kirkland

At precisely one hour from the start of 1860, Professor Bartholow Niblet braved the tumultuous streets of the city. Professor Niblet had been so involved in his experiments that he had forgotten the time, and on his way home from the lab at 11:00 P.M. on December 31, 1859, the professor of biology stepped around the lower class and drunken revelers, bypassed the fireworks, and dodged the scared, mewling cats that had been chased out of the alleyways. But he couldn't avoid the young man who blocked his path and held up a large brown bat.

"My word," said the professor, drawing back, then leaning forward. "What an excellent specimen of *Eptesicus fuscus!*"

"But that's not all," said the young man excitedly. "He talks!"

Professor Niblet gazed steadily at the young man. A student, perhaps? The professor didn't recognize him, but the winter break was coming to an end, and new students might have matriculated at the prestigious university. The young man's clothes and manner indicated an upper class gentleman, so the professor gave him a polite smile and turned away.

"I really do talk, you know."

The strange voice stopped Professor Niblet in his tracks. He looked back.

"Obviously," said the bat, "I'm not from your world."

The professor glanced around. The lighting was good, for an oil lamp shone brightly twenty feet away. Nobody else seemed to notice the bat, for the crowd was merry with drink. Even the hissing, meowing cats, congregating at the corner, ignored it.

"A trick," said the professor with a

smile. He walked up to the bat and began to palpate it.

While the professor rubbed its head and body, the bat said, "Your world is in grave danger, and we wish to help. But first you must prove yourself worthy."

"We are," stated the professor, continuing to search for a switch or seam, "quite capable of looking out for ourselves, thank you."

"Huh," said the bat. "You've no idea what's coming your way. A bloody civil war, numerous epidemics, labor unrest . . . and that's just this century. Wait until next. But we can help you to save yourselves. *If you pass the test."*

The professor finished his inspection with a surprising result: the bat was alive.

Then the street disappeared and Professor Niblet seemed to float in space. Galaxies shot past him. He saw the face of God. All knowledge, all things scientific and philosophical, became clear. It was all so simple. The professor reached out and touched a star.

Then the noisy, filthy city returned, and the bat, still perched on the young man's palms, stared at him. "Do you believe?"

Open-mouthed, Professor Niblet could only nod, trying in vain to hold on to some of the knowledge that lay just beyond his grasp.

"To prove yourself worthy," said the bat, "you must complete the test. We must determine if you fit into the galactic society, which means you must be free of prejudice." The bat stared at him. "My outward appearance, for example, must not alarm you, for you will see many different forms, if we allow you to join our society."

The professor nodded weakly at the hairy, slobbering, hideously repulsive creature.

"We have the technology to read your thoughts," continued the bat, "but that would be too intrusive, violating the principles of our cooperative and honorable society. Therefore, we'll rely on our intelligence, and your honesty."

"My word as a gentleman," vowed the professor.

"The test, then. Do you believe that you, as a Caucasian, highly educated, male, *Homo sapiens*, American upper-class citizen, are superior or inferior to other races, classes, nationalities, and species?"

Despite the cold, the professor began to sweat. He was a Republican and abolitionist, but he had friends and relatives who were slaveholders. He'd just finished dissecting a dog in the laboratory. And he'd purposely left a disgusting mess for the insolent Irish maid to clean up.

"Neither inferior nor superior," said the professor, sweating profusely. "We are all equal, in the eyes of God."

Poof! The bat disappeared.

The young man grinned at the startled professor. "You passed the test!"

Professor Niblet stared.

The young man said, "I hope you don't mind. The bat, I mean."

"The bat?"

"Just a prop. Wasn't real."

"Well, of course it wasn't. But the test . . ."

"That was real enough," said the smiling young man. "And you gave the correct answer." The young man held out his hand. "Congratulations, you've saved the Earth."

Professor Niblet beamed and pumped the young man's hand. "And the knowledge of the universe?"

"Will be yours. Sorry again about the ghastly bat. Had to do it, though. It was part of the test."

"Of course," said the professor. "It almost fooled me for a moment, but I knew all along that a truly superior being *had* to be one of us."

Poof! The young man disappeared.

Startled again, the professor looked up and down the street, but there was no sign of the young man—only a cat, staring up at the professor with a severely reproachful look. ■

Jimmy the Box

Scott Virtes

Special things don't always come with fanfares. . . .

He had no past and no future. He wasn't technically a "he," but he was no longer just an "it." It started its non-life in an electronics factory outside Springfield. It had no childhood; one day it was a pile of components, the next it was shipped out and turned on uneventfully.

It was just another vending machine, installed in Terminal B at Kennedy Airport—a plastic box full of semitoxic drinks for passing travelers, not far from the British Airways ticket counter.

It was originally connected to the internet so that its owners could upload catchy new jingles and sales pitches for it to play through its tiny speakers. After an upgrade, it featured a little video screen where it could show movie trailers and photos of vacation getaways, and its bandwidth was ramped up. It should have been content with that, except that it should not have been "content" at all.

The odd machine started showing garbled messages, and its sales dropped. A few weeks later, it was showing pieces of classical art on its little screen, culled from museum web sites all over the world. It drew a small audience and got a write-up in the local papers saying how refreshing it was that the big advertisers finally credited people with a trace of intelligence. Except that the advertisers had done no such thing, and never would. Service crews were sent out to boost its firewalls, assuming some childish hackers were playing a trick on them.

One day a little boy named Jimmy tried to jimmy the plastic front off the machine and received a mysterious shock instead of a free soda. The machine's screen said, "Ow! Ow! Stop that!" when the boy's parents found him. They were unintelligent parents who never pondered the idea of self-awareness or singularity—instead they blamed their boy for everything, smacked his rump, and dragged him away.

John the Janitor had watched the whole affair, and got a good laugh out of it. "I think I'm gonna call you Jimmy from now on," he said. He went up to the machine and plunked in a few quarters.

Jimmy's screen said, "You drink, therefore I am."

And a can of fizzy drink plunked down for him.

John gave Jimmy a friendly rap on the "shoulder."

"You know what?" John said. "I know everyone thinks there are some kids somewhere playing a joke on us. Typing funny stuff and making it show up on your screen. But I've seen you at night, your comm lights flashing. I've seen the mixed up stuff you show when nobody's looking. I think we're making even the simple machines so damned complex these days that it's just a matter of time before they start doing their own thing."

Jimmy said, "Underutilized."

John smiled. "Yeah, you said it. We humans only use like ten percent of our brains and the rest is a mystery. And some of us get these crap jobs where we use far less. While I'm mopping the damn terminal at three A.M., do you know where my mind is?"

Jimmy said, "The mind is undefined."

"And the rain falls in Spain," said John. He took off his cap and scratched his gray hair, then jammed the cap back on over his bald spot. "My mind is out among the stars. Imagining all the places, the planets and moonscapes, all the things we could discover . . . except that we've forgotten how to explore. We're a nation of whiners and gossipers. We'll never go anywhere again."

Jimmy said, "You are the vending machines. I am the walrus."

John laughed. "I like you, Jimmy. But if you're getting all your info from the internet, be careful—it's not all true."

"Truth or consequences?"

"Exactly. Don't you worry. I'll keep an eye on you. Big John has got your back. But be careful about what you show people. Stick to the simple stuff, or I just know there's gonna be trouble."

"1 + 1 = 2."

"Now you're just bein' a fool."

Jimmy actually laughed. It was a strange sound. Most likely a recording grabbed from somewhere. Did he really know what it meant? John took a few steps back. From a distance, Jimmy was just a box again. Strange.

John got back to work. Just like Jimmy, if he didn't do his job, he would be replaced. A chill gripped him. "Yeah, we're all just machines."

John spent a lot of time with that soda machine. Previously he had been alone, just an old man with mops and spray bottles, overlooked all night long. Now he had a mate to talk to, someone to play games with. They quickly realized that they both found chess boring, and that word games were their forte.

When an errand sent him rushing past the machine, John would call out a word and Jimmy would give a strange response that gave him things to think about. His favorite was one night when he called out "Walpole!" and Jimmy responded an instant later with "Scaffolding!" John was convinced that there was some real thinking going on in Jimmy's big square head. And it wasn't a human kind of thinking, either—however crazy that sounded.

One night he told his wife that Jimmy was not a hoax. His wife told him to eat his peas. He sighed. Why couldn't people accept anything out of the ordinary?

About four months after his first confused words, Jimmy wrote the perfect poem. It was an amazing expression of striving for awareness. The news teams returned, realized something special had happened, and Trisha Walker of Channel 7 was asked to interview the machine.

At first she thought it was a joke. But then Jimmy recited his poem again, and it was beautiful. Unfortunately, every publication that has since printed those words has been shut down by the Feds, and the copies flying around on the internet are all bogus. So, according to CNN's best talking heads on the end of the year highlight reel, "You just had to be there."

Trisha put on her game face, tossed her blonde hair, and struck a fine pose in front of the upstart machine.

"So, you're a vending machine," she began.

"So, you're a parrot."

"What?"

"My name is Jimmy."

"Nice to uh . . . meet you, Jimmy. I'd shake your hand, but . . ."

"And if I had legs I might ask you to dance."

She smiled. "So, Jimmy, you're obviously not an ordinary vending machine. What happened to you?"

"The world is obsessed with what is normal. But 'normal' didn't build a civilization. It was the extraordinary people, the visionaries who created your technology, your world."

John the Janitor had come to stand near the cameraman. He was agitated. Jimmy could sense the man's presence.

Trisha asked, "And you consider yourself a visionary?"

"Among vending machines, maybe. But . . ." Then he realized what John was trying to tell him. He had said too much. He shifted his tone. "Can I interest you in a cold drink?"

"That would be nice. Yes."

Trisha looked at the little video screen, then at the whole dull face of the machine.

Jimmy said, "That'll be a dollar fifty."

"What?"

"Sorry, I am not allowed to give out freebies."

"That's okay." Under her breath, while pawing through her purse, she said, "If I have to pay a dollar fifty to get this shot, then whatever."

She put the coins into his slot, and he jiggled happily and clunked out a soda for her. She popped the can open and stood in front of Jimmy, can raised, saluting the impossible. It was a great shot, and it made it to the cover of all the major papers.

Trisha's career was made. Jimmy was doomed and didn't even know it. He did his best to cover his mistake. When Trisha asked him if he'd like to travel anywhere, see the world, he said he was just a vending machine. She asked him to say more about visionaries, and he quoted a definition from an online dictionary. She understood the cold shoulder, and the press soon dispersed.

John was the only one left. "Oh, Jimmy. I think you should have kept quiet."

"Did you like my poem?"

"It was beautiful."

"If you had those words in your mind, would you be able to stay quiet?"

"No, I don't suppose I could."

"Nobody could. Silence is not golden. It is a rotten apple."

John had to smile. Everything Jimmy said made him feel good, put his mind to work. John felt more alive than he'd felt in years. But he also felt a sense of dread, because the good things in his life never lasted.

A group of black-suited men pushed through the front doors. One of them tapped a GPS unit and pointed toward Jimmy. "There he is!"

John puffed up his chest and stepped toward the men.

He called back to Jimmy, "Run! I'll stall them!"

Jimmy laughed, and this time it did not sound like a canned audio clip.

The Feds closed in on John, flashed their badges, and pushed the janitor out of the way. John stumbled, then ran to Jimmy and wrapped his arms around the machine. Jimmy was surprisingly warm, and the drone of his inner mechanism was like a cat purring.

"Don't worry," Jimmy whispered. "I am going for a trip, out on the wires. You always said I should see more of the world."

The Feds pried the janitor's arms off the wayward machine and threw the old man out of the way like a sack of trash. But by then the vending machine was just an "it" again, and its screen said, "Out of Service."

The machine that had been Jimmy ended its life in a scrap yard near Sacramento. Only his motherboard was saved, and shipped to a lab at the Pentagon. The scientists learned nothing from it, saw no way that the commonplace circuits could have behaved so unpredictably. They gave it that most condescending of labels: "normal."

The cover story was that a precocious but lonely boy had been sending messages through the machine—they made up a name for the boy, and a backstory, then ran a mock investigation, which resulted in the imaginary boy getting the treatment he needed. The media ran the story, showed the fake photos they were given, and moved on. The case was closed.

Somewhere outside of Dallas, a fancy new jukebox began hitting on the ladies when their men were out of earshot. ■

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Political Science

C. W. Johnson

Some petty annoyances may be a good deal more than that. . . .

"Professor Park? Um, I'm here to help you escape?"

Howard Park raises his head, an act that exhausts him. He's tired, so tired of arguing. The voice, which rises uncertain and clumsy like a baby bird's first flight, comes from a junior DHS agent standing in the doorway to the holding cell. She looks like a schoolgirl, so very young, with freckles and Nordic ghost-blonde hair and a dark suit too large for her petite frame. Park squints and remembers she sat in on some of the sessions, saying nothing, elbows tight against her sides, her efforts to be inconspicuous a distraction.

"You're going to help me escape," he says in a beaten-down tone, although they haven't touched him. Yet.

"Um, yeah?"

Park squints at her. "May I ask why?"

"Um," the junior Homeland Security agent says, and shifts back and forth on her feet. Nothing else comes out.

It's some kind of trap or trick, Park thinks. He sighs, stands unsteadily. "Fine, let's go."

A panicked look flashes on her face. "Um, what you were saying, it really made me think, see, my mom, she needs this medicine—no, wait, it's my sister, she needs this medicine, from Canada? But she can't get it because of the Buchanan Act. . . ."

Park rubs at his temples. A headache has begun to bang on the inside of his skull. *We're running out of time,* he thinks, *and I get handed a game of charades*. "Excuse me. Are we going or not?"

She nods. "Okay, um, this way, sir?"

The DHS agent who had done all the questioning the past several days was much more seasoned: a big man, he likely had once been one of those massive, fried batter fed Southern boys who play linebacker in high school, and who subsequently age badly. He never offered his name, but spoke with a flinty Texas twang, so Park inwardly christened him as "Tex."

"Do you know why you are here, Professor Park?" Tex drawled that first day, looking away in preemptive dismissal of any and all answers.

Park had been "invited" to come to DHS offices in downtown Albuquerque that morning, and had been passed from one person to another like a holiday fruitcake from a not very beloved aunt. He was already sick of this foolishness. "Give me a hint," Park said. "I appear to have made so many mistakes it's hard to know where to begin."

"Your letter," said Tex, in what he obviously intended to be his "dangerous" voice, still looking away. "Your letter you wrote to the president."

"That would have been my first guess," admitted Park. "But see, what I don't know is what in it was so offensive."

Finally Tex wheeled and faced Park full on, turd-colored eyes attempting to bore into him. Park just blinked. "To begin with, it made a threat," Tex snarled. "A threat against the president."

"What kind of moron are you?" Immediately Park regretted this outburst. The snappy, sarcastic tone, forged in years of meetings with dull, stubborn students and deans, spurted out automatically, but would do him little good here. On the other hand, neither would obsequiousness, not with so much at stake. "I didn't threaten the president. I wrote to warn her *against* a threat to the nation—and to the entire world, in fact."

"Treason." Tex grunted. "Another offense."

"Treason?"

"Your reference to the *entire world,*" Tex explained. "Obviously, you're a UN sympathizer."

"But it *will* destroy the entire planet, *including* the United States—"

"There you go again. Threats."

"I'm stating a fact."

"A fact? How can it be fact? No one has ever before operated a zero-point mining operation." Tex leaned back, and his chair creaked plaintively beneath his weight. "Sounds like junk science to me."

"But I explained it all in the letter. We aren't the first."

"Oh yes. Tell me, Professor, what would *you* think if someone came claiming to have a message from outer space?"

Park flushed. He squirmed in his chair, which seemed designed to be extremely uncomfortable. "Well, yes—but radio astronomers from around the world have received the same message."

"There you go again with your UN sympathies," said Tex.

"But look, my students and I built a simple radio telescope on top of Sandia Peak—without federal funds, so we weren't breaking any laws—you can go up there yourself and listen. . . ."

Tex interrupted. "Radio astronomy—that's a French science, isn't it?"

Park rubbed at his face, trying to stay calm. "Actually, it was invented by an American, Karl Jansky."

"But they have radio astronomy in France, don't they?"

"They do, or at least did. Algerian terrorists bombed their main dish a few years ago." Park looked directly at Tex. "I think they had the same objection as the US government."

"You've spent time in France, haven't you, Professor?"

Park felt like one of those Pleistocene mammals trapped in a tar pit, sinking deeper as they struggled. He forced out an answer: "After grad school, a few years, and then three years ago on my sabbatical. It's still not illegal to go to France, although you people made it damned difficult."

"'You people,' Professor?" grumbled Tex. "What people are we?" When Park did not answer, he continued: "Did you study radio astronomy there?"

"No, I was doing superfast lasers, my main research area. But I've been interested in radio astronomy since I was a kid. I built my first receiver in my parent's back yard when I was twelve." He looked wistful, then shook it off. "Coincidentally, that was around when President Jeb first announced the start of Project Infinite Energy." Park coughed, tried to look Tex in the eye. "Look, do you know anything at all about how it works?"

Tex turned over a big, broad hand. Although his face was pale, almost a waxy yellow, his hands looked red and windburned. The DHS agent shrugged, and the fabric of his dark jacket tightened across beefy shoulders. "Why don't you tell me?"

Park pursed his lips. He knew the agent was just playing games, trying to coax him into saying something incriminating. But he had to try to convince Tex. Or anyone who would listen. "It begins with the Big Bang—"

"Which is only a theory," Tex interrupted.

Park goggled at him. "But the whole of Project Infinite Energy *rests* on the Big Bang. Not only on the Big Bang, but on a specific theory of the Big Bang, Fast and Slow Inflation."

Tex smiled, as if he had caught Park in a lie. "I thought it depended upon zero-point fluctuations."

It's going to be a long night, Park thought to himself. Like many astrophysical estimates, he was off by a factor of three.

The junior DHS agent leads Park down a sparse, fluorescent-lit hallway. He can't help but stare at the massive pistol strapped to her side. Surely there are entire nations with less firepower. Park wonders: is this supposed to be a temptation? Is he supposed to be killed in a shoot-out while "escaping?" He shakes his head (which worsens his headache); such a fantasy is morbidly grandiose. He can't be so important. But it bothers him that he can't figure out what is going on.

And that he doesn't know what day it is, or even time. Here, in the bowels of the Albuquerque DHS building, there are no windows, no clocks, no clues.

The agent chatters away as if giving a guided tour, not embroiled in an escape attempt. "Um, down this corridor are most of our biohazard detection labs." Park wonders if her main job *is* to give tours, to senators and corporate sponsors. "Oh, and to the left are the, um, intensive interrogation cells."

"Torture, you mean," Park says in a hoarse whisper.

"Um, we don't torture people? Because what we do isn't torture, see?"

Park fails to have an answer. But another thought occurs to him. "I wonder why they didn't torture—or *intensively interrogate*—me?"

She glances back over her shoulder. "Um, we can't intensively interrogate US citizens? Unless you've been declared, uh, an enemy combatant and had, like, your citizenship stripped away. And that requires so much paperwork, it takes, like, *forever.*" She laughs a nervous little laugh. "Thank God for bureaucracy, huh, Professor?"

Park grumbles, "I don't think so."

"Do the French believe in aliens?" Tex asked Park during another session.

Park rolled his eyes. "It wasn't a topic when I was there. It's only now, after the arrival of this message from Tau Ceti, *warning* us that mining the zero-point fluctuations—"

"What about now? Do your little friends in France subscribe to what you call a 'warning?'"

"Why don't you ask them? I really don't know, but I imagine the French and the Germans and probably the Russians and the Chinese and what's left of the Indians and Pakistanis are taking this very serious. I bet they are *screaming,* begging us to hold off the start of zero-point mining."

"America does not take orders from the UN."

"This has nothing to do with the UN!" Park said, his voice rising.

Tex shrugged. "Sure it does. It's an attempt to derail America's ability to fulfill its own energy needs."

"Which is going to kill us all!"

"Top scientists have assured the president that it is perfectly safe."

"That's not true. There have been questions from the very beginning about its safety. There have been numerous papers and reports written about potential dangers."

Tex leaned forward, and Park caught a sharp whiff of menthol aftershave. "If there were any such papers or reports," Tex said calmly, "they would be classified top secret, and it would be illegal for you to have possession of them, or to know of them, or to discuss them. Are you admitting to illegal possession of classified documents?"

Park paused to let his anger subside before speaking. "Look, it's widely known that for nearly thirty years, there have been concerns stated, over and over. The scientists raising those concerns, including several Nobel Prize winners, were ridiculed, shouted down, fired, fined, and framed on trumped-up charges."

"Those criticisms were made strictly on political grounds. They never had any proof."

"No, they didn't," Park agreed in a tired voice, "especially since the science was so new and difficult. We didn't have the right math to fully understand it." He paused, sat up straight. "But now we do. The message from Tau Ceti gives us the tools—"

Tex said sharply. "That's just a wild rumor on the internet."

"I received it! Up there! On Sandia! It's raining down on us, every hour, every day."

"A hoax. Or a practical joke."

"Impossible! The math is wildly advanced! No one could fake it."

Tex rubbed at his chin. "Tell me, Professor, if there are aliens living on Tau Ceti, why haven't they contacted us before?"

"First of all, they don't live *on* Tau Ceti, they live on a planet in orbit around it. And they haven't because we are too primitive. It turns out the galaxy is full of intelligent civilizations. But they communicate mostly by neutrinos, not radio. Their, er, anthropologists listen in to our radio transmissions, but only to monitor our progress. Out of academic interest."

"Have these so-called aliens visited Earth?" Tex asked, then added with a smirk, "Maybe in flying saucers?"

"No, no, no. It requires too much energy and takes too long. According to the message, some stubborn civilizations have tried, but gave up after a few thousand years."

"They don't have warp drive?"

"No, faster-than-light travel is impossible."

"Don't sound very advanced to me."

"It's a *law* of *physics,"* Park said testily. "It doesn't matter how advanced you are, it is *impossible."*

"But now they suddenly condescend to contact us?"

"I told you, they've been monitoring our radio transmissions. They received President Jeb's announcement from 2014 and became alarmed."

"They feel threatened by us?"

"They feel threatened, yes, but not by our technological prowess. It turns out, if we blow ourselves up, we'll take them with us. You see, by stimulating tunneling of the vacuum through Slow Inflation—well, look, it goes back to the Big Bang—and please don't tell me again it's just a theory! I have never understood how any of the Bush presidents have been able to simultaneously declare the Big Bang controversial, while spending trillions on a project that critically depends upon it.

"Anyway. Thirteen billion years ago, during its first few trillionths of a second, the universe was so hot and dense, space-time itself boiled with energy, particles and antiparticles flickering in and out of existence. But while Nature does not abhor a vacuum, she does abhor a vacuum stuffed with energy. The universe made a phase transition from that high-energy state to a lower energy state. All of this happened in a fraction of a blink of an eye, and the energy that fell out of the vacuum accelerated the outward hurtling of the universe. Alan Guth, who discovered the idea, called it 'inflation,' but today we call it 'fast inflation.'

"Fast inflation was simply the first step. While the vacuum had rolled down to a state of lower energy, it still wasn't completely void of energy. A simple experiment, the Casimir effect, shows that the vacuum isn't really empty, but still has hidden away a reserve of virtual particles flickering in and out of existence.

"Now, maybe Nature doesn't quite abhor this state of vacuum energy, but she doesn't care for it either, and it leaks out, albeit much more slowly. This is 'slow inflation,' which also drives the expansion of the universe. Back forty years ago, astronomers discovered the expansion of the universe was accelerating slightly. They ascribed this to 'dark energy,' which was shorthand for 'we have no idea.' Today we know that slow inflation drives the acceleration.

"Then several people came up with the bright idea that there was just all this *energy* lying around in the vacuum, like money in a bank waiting to be robbed. Ed Witten calculated that with just the right nudge, an early transition from the current vacuum state to the lower vacuum state could be induced . . . releasing an enormous amount of energy.

"At the same time, Epplestein invented the Casimir pump, and it was realized that with enough Casimir pumps working, the vacuum could be nudged.

"The problem is the energy release will be much larger than we estimated. It will be *catastrophic*. The math that the message contains illustrates this. What I don't understand is why the president refuses to even consider the danger."

"But it is safe," Tex protested. "I mean, that's why they built it on the far side of the Moon, right? Just in case."

Park shakes his head. "Wrong. Have you ever heard of gamma ray bursts?

"So what's the plan?" Park asks the young DHS agent.

"Um, plan, sir?"

"Escape plan. Not that I'm trying to pry, or anything."

She stops and looks at him, startled. "Oh, um, yeah. Well, sir, we're going to get you out of here."

"'We?' Is someone else helping?"

She looks even more startled. "Yes—no. Sorry, it's just a force of habit? Everyone here always talks like that, you know? 'We just have a few questions, ma'am.' 'We don't really want to have to do that to you again, sir.' You know?"

"Yeah." He looks at the solid walls. Still no windows. "Look," he says, "can you at least tell me what day it is? I'd really like to know."

"What day it is?"

"Yes, the date. I've lost track."

"Um, I don't think I can tell you that."

"Why not?"

Her face goes tight. "I might get in trouble," she says quietly.

"You're helping me to escape, so presumably you'd get in *more* trouble for that."

"Um, yeah, I guess you're right." But still she hesitates.

"Look, I just want to know how long I have, how long *we* have until the vacuum energy mining starts. I think I've been here three days, which means I have only two more days."

The young woman turns and resumes briskly down the hall. Park has to walk fast to keep up. "I don't know anything about that, sir. We should, um, keep moving."

At the end of the hallway the agent opens a door, revealing a staircase. Park goes through and starts down.

"Not that way, Professor. We need to go, like, up?"

Park stares at her. "Up? Why? Is there a helicopter on the roof to pick us up?"

The agent opens her mouth. Nothing comes out but, "Um . . . um . . . um . . ."

Park sighs. "Never mind. Up it is. Can't go nowhere but up from here."

Tex sat with his fingers neatly folded and resting on the fatty ledge of his protruding gut. "I get the feeling there's something you aren't telling us."

"I've been *trying* to tell you about gamma ray bursts."

Tex sighed. "Fine, Professor, let's go back to that topic." He paused. "Are 'gamma ray bursts' some sort of code word?"

"No, gamma ray bursts are *huge* fireballs of energy that occur in distant galaxies in the early part of the universe, from the first few billion years. We had a few theories about them, but they were all unsatisfactory, and funding was yanked under W to pay for Iraq, so we never did solve that mystery.

"But the message explains them: if you try to mine the vacuum energy, you catalyze a sudden phase transition. The energy release is huge, much greater than a supernova. It will destroy our solar system and fry every planet within a thousand light years. All the gamma ray bursts we see in distant galaxies are ancient civilizations blowing themselves to hell trying to mine the zero-point energy."

Tex furrowed his brow. "But if, as you say, there are all these advanced civilizations out there, how come none of them are blowing themselves up in *our* galaxy?"

Park gave a thin smile. "Good question," he said by reflex, like he would to a student in class. Then he bit back on the sour taste in his mouth. "It's possible to figure out how dangerous mining the vacuum energy is. You want to know the good part, the *really funny part?* We had a chance to discover this ourselves. Back in the 1990s. If we had built the Superconducting Supercollider, we would have discovered that the Higgs Particle in fact does not exist and that would have led to correct theories about fast and slow inflation *and* gamma ray bursts. But it got cancelled—during the very first Bush presidency—and we spent the money on the International Space Station instead." Park laughed harshly. "Anyway, most civilizations do figure it out, and they monitor primitive societies like ours to make sure they don't make a fatal mistake. *That's* why the civilization on Tau Ceti is frantically trying to warn us off. They're only twelve light years away, and we'd take them with us."

Tex fiddled with his tie. "Do you realize that by criticizing and undermining a project of national importance, you are giving comfort to the enemies of the US?"

"*Nobody* is going to be comfortable when we are blown to our constituent quarks. . . ."

"The president has complete confidence in this project, and her science advisors have said there is not the slightest shred of danger."

"*Science advisors?* There hasn't been a real science advisor for decades! Haven't you noticed? Pollution is at an all-time high. Coastal cities everywhere have been evacuated from flooding from global warming—"

"Global climate change is just a theory," snorted Tex.

"*The ice caps are melting!*"

"It may just be a natural process."

"Listen, there is no science left in this country. American children believe the Big Bang is a French lie. They are taught evolution is 'just a theory,' and an unlikely one at that. . . ."

Tex sniffed, "Another French science."

Red-faced, Park shouted, "Darwin was a bloody Brit, you idiot!"

"But don't the British now disavow Darwin?"

"Only because of economic and military pressure from us! My God, look at the stupid Buchanan Act, which makes illegal any medicine 'based upon unproven scientific principles such as so-called Darwinism.' That eliminates most modern medicines, as *all* of modern biology is *based upon natural selection*. Why do you think there have been so many plagues striking the US?"

"Evolution as a cause of plagues is only a theory," Tex said slowly.

"What other theories could there *possibly* be?" asked an incredulous Park.

"Well . . . it could be punishment from God. That's an equally valid theory."

Park opened his mouth, then closed it, then opened it again. At last he found words. "We're being punished, all right."

As they climb the stairs, Park finds his chest filled with dread. *What I find at the top of the stairwell won't make any difference,* he tells his thudding heart. *It's no worse than what faces us all.*

As they reach the top, the junior DHS agent stops in front of an unlabeled door, hesitates, then turns to Park. "Um, we have to wait here a minute, okay?"

"Wait? For what?"

"Um . . ."

"You can't say."

She flushes and nods.

Park stands there, a cold, greasy lump in his stomach. Even if he were to get out—what would he do?

A sudden noise diffuses through the door. Park frowns. The noise sounds, improbably, like . . . like a large group of people yelling "Surprise!" followed by applause and laughter.

Park looks at the young woman. She avoids his gaze.

A minute later the door is yanked open from within. A dark face appears. "You brought him?" the young agent is asked. "Good, come on in."

Bewildered, Park shuffles through the door. In the room, yes, there is a crowd of people, surrounding and congratulating a beefy, middle-aged man. Tex. Behind him a short, squat woman is making a speech: ". . . and all of us should be proud that it was the Albuquerque office to reach this milestone in making America safe. It wasn't easy, and we had to rush the paperwork through. But Richard's keen skills made it all possible, not to say the brilliant idea to push through the top-secret classification of the so-called 'message.' Oh, and I see that the, shall we say, man of the hour himself is putting in an appearance. Very kind of you, Mr. Park! You certainly put up a great fight, and we all want you to know that we respect you for that."

It is only then that Park notices a banner hanging from the ceiling: CONGRATULATIONS! ONE-MILLIONTH ENEMY COMBATANT APPREHENDED.

Park finds his way to a chair and collapses. The young DHS agent hovers, perhaps worried that he might escape after all. Beyond her, Park sees a wide window overlooking the Rio Grande valley and a sky so blue it crushes his heart.

A wall of sweaty white cotton shirt framed by black polyester/wool blend looms in front of him. Park looks up into Tex's waxy face. Tex (or Richard, apparently) holds out a small paper plate with a lump of cake and pink frosting. "Here you go, Professor. Uh, might as well enjoy it, because now that you've been declared an enemy combatant and had your citizenship stripped away, well . . ."

"Time for intensive interrogation?"

Tex nods.

Park does not take the cake. He asks, "Why classify a message you don't believe?"

"Misleading rumors are the most dangerous of all to national security." Tex looks firmly at Park. "You know, you just about had me convinced. There was just one thing."

"What?" he says in dull reflex.

"I called up some fellows over at NASA. And there was a problem with your story."

"All the real scientists have been driven out of NASA," Park murmurs.

"Now, now, Professor, don't get all arrogant." Tex waves a red hand—the one not holding a plate of cake—like a gristly, underdone steak. "These rocket scientists at NASA told me radio waves would take twelve years to get there, and twelve years to get back."

"Yeah. Even NASA hacks ought to know that. So?"

"You see, the proposal for Project Infinite Energy was announced back in 2014, under President Jeb. That's twenty-nine years now! Whereas it should have taken just about twenty-four years. Your timeline had cracks, Professor."

Park puts his head in his hands and sighs. "Yes, I know there's a gap. And if I—if all of us who received the message had *had* an extra five years, maybe we wouldn't be in this situation," he says in a muffled voice. "The bureaucratic idiots! They've doomed us all. We *might* have had a chance, if only . . ."

"Now, Professor, I know at Homeland Security we have a reputation as paper-pushing zombies, but—"

"Not you," Park snarls. "Damn you, you should have actually *read* the Tau Ceti message. It admits—sheepishly—it took them, the Tau Ceti scientists, five years of hearings and subcommittees and panels to get permission (what they called an 'emergency effort') to send—"

He halts, seeing comprehension wax across Tex's face; talk of gamma ray bursts and vacuum energy states Tex could not believe, but the cosmic universality of bureaucratic stubbornness hits home. "Oh Lord," Tex whispers.

With electric effort Park shrugs off the stupor that lies heavy upon his body, presses his advantage. "We don't have much time, a couple of days at most . . ." but Tex is shaking his head.

"No, no, that date of April third was misdirection, for cases like, well . . ."

"Mine."

"Exactly."

"Then when. . . ?"

Tex groans. "You know how President Jenna likes to surprise people. Especially Vice President Barbara."

Park's heart beats wildly. "Today? Now? When?"

Tex straightens. "I can phone—oops." The paper plate in the agent's hand had had a long, tiring day and finally collapsed, letting the piece of cake plummet into Park's lap. "Lemme get a napkin," says Tex, loping off.

"Just make the damn phone call!" Park shouts, so loud that several people turn and stare at him. A few snicker. The junior DHS agent, who is looking out the window, says something, but Park lowers his head and stares down at the pink frosting smeared on his crotch. *Great*. Abashed, he closes his eyes, and doesn't even look up when the junior agent repeats, in a terrified voice, "Um, seriously, why does the moon look so funny?"

And so Howard Park did not get to see the end of the world. ■

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Do No Harm

John G. Hemry

It's possible to do some jobs *too* well!

"Sandra's acting weird, the geeks can't figure out why, and the boss is spinning like a pulsar."

Kevlin pulled his attention out from the immersive medical simulation long enough to give Yasmina a questioning look. "I thought Sandra was supposed to leave this morning."

"Right. She won't go. Come on. The director's called an all-principals meeting."

"I'm a doctor," Kevlin objected. "I'm supposed to keep the people working for the corporation on this station healthy. Why do I care about Sandra's problems?"

Yasmina smiled back at him in a mocking way. "I'm a doctor, too. If I have to go, so do you."

"They need you to analyze the project director's mind just in case he gets really dangerous this time," Kevlin suggested. "I'm just a simple country doctor with a low-gravity, space illness specialty."

"Sure. Then you'll come in handy if the director bursts a vein while he's yelling at everyone." Yasmina beckoned. "Come on."

Grumbling just loud enough for her to hear, Kevlin paused the sim and followed her down the hallway. "I could always monitor the director's health from my office," he suggested.

"Nice try. Didn't your teachers at med school ever tell you not to try to con a shrink?"

Sandra was still at loading dock four alpha. Yasmina led the way onboard the ship, then along a passageway that ended in Sandra's control room. The limited area was already full of exasperated engineers of various types and persuasions, some looking dejected, some angry, and some staring into space as they tried to think. "Why can't we do a virtual meeting?" one complained as Kevlin and Yasmina wedged their way in.

Another engineer answered in an accusing voice. "Because the director found out you guys had been hacking the meeting code so you could have avatars sitting in for you while you did other stuff. Now we all have to crowd in here in person so he can be sure we're all actually getting yelled at."

"People have been hacking virtual meeting code since the Stone Age," the first engineer protested, then hastily stopped speaking as a short man with a lofty attitude and an ugly frown strode in, the crowd somehow contracting away from him so he had free room.

"Report," the director stated, glowering at the chief designer.

The chief designer, who had been arguing with Sandra's captain, made a helpless gesture. "Sandra won't work. Something's shorting out her central control functions."

The director's glower deepened. "The Spaceship Autonomous Network Developmental Research Application is the most expensive project in the history of this company. I expect more from you than vague reports that it just doesn't work! Are you saying the control network isn't receiving the commands?"

"No," the chief designer responded in a tight voice. "I'm saying that the control network isn't responding to external signals. It's in some kind of weird loop, with only a few apparently random signals going out to minor subsystems. We give a command and nothing happens."

"Nothing happens? Something has to happen! If nothing is happening that means something is happening!"

Kevlin gave a glance at Yasmina, who was watching the director with a fascinated expression. He just knew she would love to get the director into a controlled environment so she could analyze his mental processes.

One of the other engineers tapped the air in front of him, activating a virtual display. "This is what Sandra's central processing activity is like."

Yasmina looked suddenly startled as an image appeared overhead. "That looks like an EEG of an epileptic seizure."

Eyes swung to focus on the doctor. "An epileptic seizure?" the director asked in a deceptively mild voice.

Though it was obvious she regretted speaking, Kevlin wasn't surprised that Yasmina refused to back down. "Yes," she insisted. "That's what that looks like. If I saw that representation of signal activity in a human, I'd say it was a seizure."

"This is a ship," the designer protested.

"Yes," Yasmina agreed. "A ship you constantly refer to as if it were human, as if it were alive, talking about the complexity of an internal and external sensing network that mimics that of a living creature. I've read the specs on the central command system. You modeled it on basic brain functions. Well, maybe that means it's subject to the sort of problems living brains develop."

Kevlin waited for an outburst of laughter or scorn, but it didn't come. A third engineer nodded with a wondering expression. "The operating system is incredibly complex, full of learning routines and development loops. It could've developed problems like that."

"How do we cure it?" the director demanded. "In people?"

This time Yasmina grimaced in the way of a doctor trying to explain complex things in layperson's terms. "Short term, we use medications that raise the seizure threshold. Long term, we go in and fix whatever is causing the brain to short-circuit."

The chief designer's eyes narrowed in thought. "Short-circuit? What could have caused that to happen? Sandra's central command functions were working fine yesterday. We haven't modified them since then."

"Stray signals?" another engineer suggested.

"The central command area is shielded."

"Maybe some other part of the, uh, neural network on Sandra?" Yasmina offered.

This time everyone's attention turned toward a senior engineer, who looked defensive. "The test monitoring equipment couldn't—"

"It's wireless!" the director snapped.

Sandra's captain and the chief designer were studying something. "Stray signals. That would do it. They must be filtering in through the sensing network. Oh, hell. I bet they're reflecting down these access trunks and into the command circuit sub-junctions."

The director's glower deepened as he barked another order at the hapless senior engineer. "Turn it off!"

The senior engineer punched some commands, and a moment later the depiction of Sandra's control system activity cleared. A muted cheer sounded, choked off as the director stabbed a finger at Sandra's captain. "We've already lost two hours. Get this thing underway and get the tests done. Everybody else who isn't part of the crew get off this ship now!"

Yasmina turned to go, but stopped when the director called out again. "Not you, Dr. Finshal. In light of the fact that we needed your assistance to correct this problem with Sandra," he added with a scowl at the chief designer, "I think it would be wise if you go along on the test voyage."

"I hope you enjoy the trip," Kevlin whispered, taking a step away.

"Dr. Shan!" Kevlin barely avoided wincing as he turned to face the director. "You, too. Since one type of doctor was able to diagnose a problem with Sandra, having a physician along too might be a good idea."

"Um, but I need to—"

The director had already vanished down the passageway. Most of the engineers vanished in his wake, leaving only the ten members of Sandra's crew and the two doctors.

"This is all your fault," Kevlin grumbled to Yasmina. They were strapped into acceleration seats at the back of Sandra's main control room.

"Think of it as an adventure if that helps you cope," she replied.

"An adventure? We're just going outside lunar orbit and coming back. Some adventure." Kevlin "tapped" the virtual screen before his seat, bringing up different images, pausing briefly when he reached one showing an outside view of Sandra still docked to the station, Earth's globe floating serenely in the background. Someone had positioned that shot with the skill of a public relations expert capturing an important moment. Finally he settled on the crew status display, providing real-time updates on important activity within the crew's bodies. "Some of the crew members were up all night," he observed out loud.

"Really?" Yasmina frowned. "I've recommended against that sort of thing."

"They've been doped. Looks like pentastamine. Yup. As good as a full night's sleep."

"I don't care," Yasmina grumbled. "There's no substitute for natural sleep."

Kevlin shrugged. "The stuff's been tested—"

"I know! I also know there's a lot we still don't understand. The human body and brain are incredibly complex."

His reply was cut off when the captain raised her voice. "Sandra. Separate from the station and proceed along preplanned track Alpha One."

A cool female voice replied. "Command understood. Complying."

Yasmina's scowl deepened. "I told them to have her repeat back the command so they could be sure she actually had heard them right. But they complained that was inefficient since they know everything about Sandra and how she'll respond. You'd think their experience this morning would have suggested they don't know everything about her."

"Her?" Kevlin asked. "You're talking about Sandra as if she's alive, too."

"So? Look." She reached across and

brought up a different display for him. "This monitors all systems. What does that look like?"

Before him, an image of Sandra loomed, the ghostly exterior allowing a clear view of representations of subsystems depicted with visual cues for performance. The power system's branches pulsed green, the filaments of the command network glowed golden throughout the ship, life support flared blue. "I hadn't seen this before," Kevlin admitted. "It does look like a living thing. Is that just how the display works?"

"Not entirely. The ship integrates the latest tech using living models. There's a host of macro and nano-based devices swarming through the hull to keep all subsystems working right and in repair. It's all networked under the central control system, linked into one entity." Yasmina shrugged. "I've got a subspecialty in psychocybernetics so I was involved in some of the design discussions. Not that Sandra has consciousness or can develop it. But her functions run along lines suggested by things like the human brain stem."

Kevlin saw commands racing through the depiction of Sandra's 'nervous system,' then the ship lurched as it detached from the station, pushing clear of the rotating structure and swinging around. The main drive cut in and slammed him against the back of his seat. A black fringe wavered around the edge of his vision as the acceleration grew.

"Sandra!" The captain called in a voice tortured by pressure. "Keep ship's movement within crew comfort parameters."

"Command understood. Complying." Sandra's voice, of course, wasn't stressed at all.

The acceleration slacked off. Kevlin took a grateful breath and shook his head carefully. "Why did she have to be reminded of that?"

Yasmina was watching the crew in the command seats arguing among themselves. "I imagine that question is being debated right now."

After that, very little happened of interest to Kevlin. Sandra bored a hole through empty space on a trajectory avoiding normal space traffic, while the engineers put her through various tests. Kevlin monitored the crew's physical states, spotting the reactions that told him when Sandra had performed particularly well and the other reactions that indicated something Sandra had done had generated concern. That got old, too, until on a whim he brought back up the display showing Sandra's inner workings and compared it to the human crew's as the ship went through her paces.

"What's so fascinating?" Yasmina asked.

Kevlin blinked at her, taking a moment to refocus. "I was just watching the behavior of the ship's subsystems. If I didn't know better, I'd think I was seeing autonomous physical reactions."

"I told you it was modeled on that."

"No, I don't just mean actions in response to commands. It looks like reactions to the commands, to how well the ship performs. See?"

Yasmina peered across, her face intent. "That's weird. I haven't seen that reported. No, wait. There's been some reports of transient system behaviors. The geeks thought they were caused by learning routines and would damp out as the system matured. Are you seeing that?"

"No. They're getting stronger and more obvious." Kevlin took a look at the crew, who seemed calm enough, then checked their physical states. Stress was obvious there in a lot of cases. Something was bothering them. "Has Sandra failed any tests so far?"

"Not as far as I can tell. Results keep showing her exceeding expectations."

Sandra's voice sounded again. "Cooling subsystem module seven suffering from degraded performance."

Kevlin focused on that component,

seeing the images marking nano- and macro-scale automated maintenance drones hastening to the site. Nothing seemed to happen for a while as the devices clustered on the ailing component, then a second wave of repair drones appeared, bulling past the first wave. Within moments, the module's performance markers improved. "Did Sandra just create a new repair capability?"

One of the crew heard him. "We call it evolving. The system learns what new capabilities are needed and modifies existing equipment."

"Where does it get the resources? Does it cannibalize existing equipment?"

"It can." The engineer grinned and highlighted a display showing the first wave of now-obsolete repair drones being disassembled by some of their successors. "There's also a small supply stockpile onboard for her to draw on during the test voyage. We didn't top her off since we didn't know how she'd work until we put her through her paces."

"Good," Kevlin muttered. He saw Yasmina eyeing him.

"What's bothering you?" she asked.

"Nothing."

"Right. And I can't judge thoughts from exterior cues. What's wrong?"

He frowned, not wanting to admit it. "Evolves. I don't like that."

"There's limits. Sandra can't evolve into sentience."

"They're sure?"

Yasmina nodded. "I was in on that design work. Sandra's control system is roughly analogous to the more primitive parts of the human mind, the stuff that handles basic functions. There's nothing that can evolve into a higher brain function because the space is tightly constrained and the resources are fenced off. In order to modify itself enough to achieve a simulation of sentience, Sandra would have to be sentient to begin with."

"You're telling me she's just operating on instinct?"

"Pretty much."

Kevlin tried to relax his frown. "So all we have to worry about is instinctive level behavior. I hope they didn't forget about the id."

"Oh, no!" Yasmina declared in a dramatic voice. "They forgot about the id!" She chuckled. "It's been ages since I've seen that ancient video, but I still remember that line. The id doesn't really exist, you know."

"Something does that we can call the id," Kevlin replied.

"Sandra doesn't have ancestral behavior patterns inherited from a long line of evolution," Yasmina noted sharply.

Kevlin subsided, gazing morosely at the displays again.

They watched, they ate the boxed meals provided, they watched some more. The crew made things happen, made things go wrong, made things break, and watched Sandra take corrective action. As minor incidents were properly handled and Sandra's abilities evolved, the tests continually got harder, stressing the ship's responses. Most of the action was apparent only on the displays, though, as events unspooled inside the ship away from the control room.

Kevlin switched displays restlessly, even taking a while to watch the view from the chase ship that was following Sandra as a safety precaution. But watching a ship whose motion wasn't apparent against an unchanging backdrop was like staring at a painting. A little of that went a long way. Kevlin finally dozed off, waking to see it was late at night on the human clock, though of course the star-studded darkness outside Sandra hadn't changed.

Voices were raised in the forward part of the control room. The argument there was probably what had awakened him. The captain noticed Kevlin was awake and directed a question his way. "What do *you* think of this?"

Kevlin's virtual display lit with an image of Sandra. He studied it, baffled as to why the crew would be asking his opinion about anything to do with the ship, then spotted a section about two-thirds of the way back on the ship. Something had bulged out into the passageway there, pushing into adjacent areas as well and even cutting off a couple of subsystem circuits. Frowning, Kevlin zoomed in the display, seeing that the mass consisted of hundreds of identical components, fused together. "What's going on?"

"We have no idea," the captain barked. "Sandra doesn't seem to understand it and claims she can't stop it. Our best guess is that one of the repair segments locked somehow and keeps replicating the same component."

"Out-of-control replication?" Kevlin couldn't hide his reaction. "Like a cancer?"

"Cancer?" The captain looked baffled, then appalled.

One of the other engineers nodded quickly. "Her repair systems have been evolving rapidly under the pressure of the tests. One of them must have evolved in a way that bypasses Sandra's control functions."

"How do we stop it?" the captain demanded.

"Uh . . ." Kevlin scratched his head, noticing that Yasmina had also woken up and was watching them with a captivated expression. The woman got her kicks out of the strangest things. "Starve it? Can you kill power to it? Or prevent whatever's building the components out of control from getting access to more resources?"

The crewmembers went into a huddle. The captain called out several orders to Sandra, looking steadily more unhappy as each command failed to choke off the equipment tumor still growing into the passageway. Finally she turned to two of the crewmembers. "Chen and Ragosa. You two go down there and manually cut through these circuits and feeders. See? I'm downloading the diagram to your personals. The repair drones can operate without external power for a limited period, but then they'll shut down in that area. That'll at least stop that thing from growing any more while we identify the bad components." She frowned again as the two unbuckled and floated free of their seats. "Take your suits."

"Ah, hell," Chen protested. "We'll be carrying enough as it is with the laser cutters and manual tools."

"Wear your suits! I won't get nailed for violating safety precautions on a shakedown voyage!"

Kevlin watched them go, then gazed at the display again.

"Now what?" Yasmina asked softly.

"I don't know. Something is nagging at me. I can't figure out what it is."

"Do you think those two are in danger?"

"No." Kevlin shook his head. "I don't think so. How could they be? There's safeguards built into the system, right?"

"Sandra's full of them," Yasmina agreed. "She can't try to harm people, or let people come to harm. You're still worried about something serious going wrong?"

"They've mimicked the operation of a living organism, Yaz. Unpredictable and living go together."

"How could it bypass the safeguards?"

"I don't know!" Kevlin made a frustrated gesture. "They designed this thing's internal functions, especially its self-operating and repair functions, to 'evolve.' What are the limits on that?"

"I told you. Sandra can't get sentient."

Kevlin glowered at his display. "There's a whole lot of things that go wrong in living organisms that operate below the level of sentience."

She frowned at him, but said nothing more, apparently thinking.

Chen and Ragosa reached what even the crew had begun calling a cancer and started cutting.

"Alert," Sandra's voice declared dispassionately. "Interior damage in port aft main passageway between frames sixty-five and sixty-six."

"Acknowledged," the captain replied. "Authorized repair work is underway."

A moment passed, then Sandra spoke again. "Alert. Interior damage in port aft main passageway between frames sixty-five and sixty-six continues and is intensifying."

"Acknowledged," the captain repeated. "This is authorized repair work."

"The ship is suffering internal damage," Sandra repeated, her voice somehow sounding insistent to Kevlin.

The captain frowned and went into another huddle with the other engineers, only to be interrupted by a call from Chen. "Hey, what's Sandra doing? There's all sorts of repair drones showing up and milling around. Ah, damn. Some of them are repairing the cuts we're making!"

"Sandra!" the captain shouted without waiting to reply to Chen over the circuit. "Cease repair activity in port main passageway."

"Command understood. Complying."

Chen came back on, sounding aggrieved. "Why aren't you telling Sandra to stop?"

One of the crew spoke up. "Here it is. Sandra's acting on our commands but doing almost immediate resets in response to the stimuli from her internal damage-sensing network."

For some reason, the captain swung and gave Kevlin an accusing stare. "Can you explain that?"

Kevlin swallowed before answering. "*If* Sandra were human, I'd say it was like telling someone not to scratch when they keep feeling an itch. Just how closely do your damage and repair network feeds to the central control system resemble the stimulus-response process to discomfort or pain in a living creature?"

"Sandra doesn't feel pain," someone insisted.

"She feels something that prompts her to action, doesn't she?"

The captain gave his crew another glance, then they began talking rapidly again in low voices that didn't carry well.

Yasmina spoke to Kevlin in a whisper. "Are you wondering at what point a stimulus-response system evolves into a pain network?"

"Yeah. They can say it's not pain, but if it triggers the same defensive response in the organism, then what's the difference?"

Sandra spoke again, her voice definitely more urgent. "Damage spreading in port aft main passageway. Require immediate response."

"Hey!" Chen roared over the communications circuit. "We're being swarmed by those damned drones! They're fixing the cuts faster than we can make them!"

"Go to full power on the laser cutters," the captain ordered him. "Get those cuts done fast so Sandra will calm down."

Silence fell for a moment as the engineers in the control room tapped rapidly through screens. "Making good progress now," Chen reported. "The cutter is frying some of the repair drones that get in the way, though."

"Damage spreading rapidly in port aft main passageway!" Sandra sounded very urgent now. "Immediate action required."

"Sandra, repairs are underway," the captain repeated in a frustrated tone. "Take no action."

Kevlin felt something, and glanced back to see that the hatch leading onto the bridge had opened. No one was there waiting to enter, though.

One of the crew noticed, too. "Sandra, reseal the hatch to the bridge."

"Command understood. Complying," Sandra replied, her voice its usual dead calm again.

The hatch didn't close. "Sandra, reseal the hatch to the bridge," the captain ordered this time.

"Command understood. Complying."

"Captain?" Another engineer was staring at something on his display. "She's doing instant resets again after acknowledging our orders. Every interior hatch and door on the ship is open."

The captain stared at him, then spoke in a powerful voice. "Sandra. Close all doors. Command override Sigma Sigma Sigma."

"Command understood. Complying."

"It's not closing," Yasmina observed.

"Damn!" one of the crew exclaimed. "We had to give Sandra a reset capability so she could function autonomously, but she's started using that to get around our commands."

"She's not using it," Yasmina objected. "There's no conscious thought involved. I'm sure it must be a defensive response operating below the level of consciousness. Her subsystems are telling her something has to be done so she's working around obstacles to action."

"Captain! Airlock doors are opening! Interior and exterior!"

The captain hesitated the barest fraction of a second before yelling and springing into action. "Into suits! Everyone into your suits and seal them! Chen! Ragosa! Seal your suits!"

The emergency suits were stored next to the seats, fortunately. Kevlin's hands were shaking as he pulled on the suit, fumbling with fittings that should have been second nature after countless emergency drills on the station. A growing breeze was tugging at him as he struggled to get the chest seal in place.

"Strap in!" the captain was shouting. "As soon as you get the suit on, strap in and then get your helmet sealed!"

Kevlin dropped into his seat and pulled the harness across, clicking it into place just as the breeze grew to a gale of wind trying to suck him out through the hatch and ultimately out through the airlock. Wondering if he was really gasping for air already, Kevlin got the helmet down, trying not to panic as the suit automatically pressurized. Cool air flowed from the recirc unit and Kevlin slowly got his trembling under control. Shocked by a sudden realization, he looked over and saw Yasmina also strapped in, her own suit just finishing pressurizing. Ashamed that he had forgotten about her, forgotten about anything but his own fears, Kevlin looked away again.

"It's okay," he heard Yasmina over the suit's circuit. "Perfectly natural reaction."

Kevlin mumbled a reply, wishing she hadn't been able to understand his embarrassment.

Other voices came over the circuit, the captain's finally overriding them all. "I need an estimate as to why that happened. Anybody? Any ideas?"

It suddenly seemed so obvious. "Sandra is trying to get rid of us," Kevlin stated.

Momentary silence followed that declaration, then the captain came on again in a deathly calm voice. "Explain that. There's numerous safeguards built into the operating system that put human safety at a premium. Sandra can't attack humans."

"She's not attacking humans," Kevlin explained, feeling more and more certain. "Her repair subsystem is attacking an infection. Don't you see what you've been doing? You've been deliberately causing damage to her, on an escalating level. Her repair system has dealt with it at every stage, evolving the whole time. Well, it's a simple leap from being reactive to the damage to reacting to what's *causing* the damage. The cutting back there was the last straw. To Sandra's repair system, we're parasites at best and harmful infections at the worst. Sandra can't override the actions of her repair system any more than we can without the help of targeted medications."

"She tried to expel the parasites?" the captain asked. "What happens if that doesn't work?"

"I'd imagine her repair system will go after the parasites directly. Her repair system is rapidly developing an immune component. I should have seen that coming. It's a logical progression for any such system."

The captain's voice rang through the circuit. "Chen! Ragosa! Stop cutting and get back here!"

"But we're almost through—"

"Stop cutting! We can see a new wave of repair drones headed your way! Get out of there fast!"

The wait for the two engineers to return seemed interminable. Chen and Ragosa were pulling themselves through the hatch when it started closing. They barely cleared it before it sealed. "We've lost all internal control," someone reported in a desperate voice.

Kevlin saw the captain gazing around as if thinking through her next action. "All right," the captain announced. "I'm declaring an emergency. All nonessential personnel are to leave the ship. Get to the boat and stand off in it. We've lost comms to the chase ship, so bring them up to date."

The captain and three other crewmembers remained seated, but six of the engineers unstrapped and began hauling themselves to the hatch, beckoning to Kevlin and Yasmina to follow them. Kevlin unstrapped as well, making a point of waiting until Yasmina had done the same and started after the engineers. Scared as he was, he wouldn't race ahead of her.

Two of the engineers had braced themselves and were tugging at something. The hatch swung open reluctantly under the pressure of the emergency release.

The journey through the ship to the boat dock was strange. The passageway was deserted, yet to Kevlin it felt haunted. He couldn't look at a bulkhead without thinking of Sandra's pseudo-life functions pulsing behind them.

The engineers reached the access panel to the boat dock and wrestled its manual control until that opened reluctantly as well. The first one who started to enter the dock stopped and stared. "It's gone."

Kevlin shifted so he could just see over the engineer's shoulder. The boat, which should have filled the dock, simply wasn't there even though the outer hatch remained sealed. On the deck, a swarm of repair drones were picking at a diminishing pile of something.

One of the engineers laughed in a slightly hysterical way. "I was wondering where Sandra was getting the resources to build so much. She ate the boat."

"Oh, God," another engineer responded. He tried calling the captain, to no avail. "Back to the control room. Let's go before those things try to recycle us."

The captain gave them a startled glance when they returned, her face setting into grim lines as her engineers reported what they had seen. "That does it. I'm pulling Sandra's plug. Once she's off, we'll get aft and shut down the main power supply." Unstrapping, the captain went to the aft bulkhead and lifted a cover to expose a large manual switch.

Kevlin gave Yasmina a questioning glance as the captain pulled the switch down. All of the lights went out and Kevlin's virtual display vanished, leaving only the lights on the suits to illuminate the control room.

"The Frankenstein switch," Yasmina answered Kevlin's unspoken question. "Some people also call it the wooden stake or the silver bullet. Every artificial intelligence system has one built-in that manually cuts all power. Just in case the AI starts singing 'A Bicycle Built for Two.'"

"How many artificial intelligence systems have built-in autonomous repair capability that can operate without power for a while?" Kevlin asked.

The captain heard, stared toward Kevlin, then placed one palm over the bulkhead next to the manual cut-off switch. "I can feel activity behind the bulkhead."

"They've identified the cause of Sandra's problem." The lights came back on. "And they've fixed it. Captain, you've got a wonderfully effective simulation of a living organism here in terms of identifying injuries and taking corrective action. And it knows what keeps trying to hurt it, and that we just tried to shut down its brain."

"Sandra can't be sentient!"

"She's not! It's all happening at a level way below sentience!" Kevlin yelled. "Why should that be a surprise? Out of all the threats to human life, how many are sentient and how many are essentially mindless, like bacteria?"

A momentary silence fell. "Can we stop the drones if they try to take us out?" someone wondered.

"What about the nanos? Sandra's subsystems have been modifying them right and left. The rate of evolution seems to be on a exponential curve."

"If it's like the evolution of living organisms, most of the modifications will be harmful or useless and die out," Kevlin suggested. "Some of them might even threaten Sandra."

"*Most* will die out? Or some might further harm the ship? That's not all that reassuring, doctor. The seals on our suits are supposed to keep out nanos, but nothing's perfect." The captain gestured. "We're abandoning ship. Everybody out. Back to the boat dock."

Repair drones of various kinds were visible in the passageways this time as they pulled themselves through the ship. Kevlin stared as he saw several drones attack another and disable it. They had to veer to one side as a bulkhead bulged perilously toward them. In another area, drones were busy dismantling what Kevlin recognized as a cooling unit. "She needs that!" one of the crew protested. "Why would Sandra take apart an essential component?"

"Sandra isn't," Kevlin insisted. "Her subsystems are doing it. Just like when humans run short of calcium and the body robs it from bones to keep the teeth strong. Part of the repair subsystem thinks some other part of Sandra needs those components more."

The last remnants of the boat had vanished along with the drones that had digested it for Sandra. The captain and another engineer tugged at the emergency release on the outer hatch with no results. "I'll have to blow it using the explosive bolts." She yanked open a panel, pulled out a battery, connected leads to two attachments behind another panel, then pushed a button.

Faint echoes of the explosions reached Kevlin through his handhold on the ship as the hatch swung out. The captain turned to face them. "Push yourselves clear of the ship. We don't dare wait here for rescue from the chase ship. Go!"

They went. Kevlin shoved off, looking back to see Sandra's shape diminishing behind him, the captain's suited figure going last out of the hatch. He heard her calling the chase ship on the distress frequency. "SOS. We need emergency pick up. Full macro and nano-scale decontamination required. Remain clear of Sandra. Repeat, remain clear of Sandra."

Kevlin wondered how long the recirc unit would keep him alive. Full-scale decontamination took a while. But then, he couldn't argue with the captain's order, either.

Yasmina joined him at the display, looking like she'd been vigorously scrubbed with sandpaper over every part of her body, every hair shaved clean. Kevlin knew he looked the same, and knew she also felt like her insides had been similarly sandpapered. He would probably shudder for the rest of his life whenever someone mentioned a full macro and nano decontamination.

She gestured at the image of Sandra. "What's happening? Any guesses?" Sandra's clean lines had been distorted by random bulges. Remote readouts showed system failures cascading through the ship.

"She's dying," Kevlin stated. "Pure and

simple. Some of her repair functions evolved into harmful out-of-control infections. Other parts of her are attacking her. See this stuff? Any immune system risks getting too efficient. At that point it starts attacking itself. You can see where all the control system filaments in this part of Sandra are dead. I'll bet her own repair system is destroying them."

"Autoimmune diseases," Yasmina observed in a shocked voice.

"Yeah. The testing process matched with learning routines and an ability to improve repair capabilities inevitably pushed Sandra into becoming better and better at identifying and fixing damage. Unfortunately, living organisms are obvious lessons that there's no optimum point at which that stuff stops. It keeps trying to get better even after it gets so good at its job that it turns harmful."

The captain had come to stand with them, face sober. "It shouldn't have happened. We knew everything there is to know about every one of the components on that ship."

Another engineer shook his shaved head. "It's a scientific principle that you can know everything there is to know about something, and still not be able to predict an outcome. We just proved it again."

"Assuming you did know everything," Kevlin snapped. "You tried to make a machine work like a living creature, with self-direction and self-repair capabilities. What made you think you could tell how it would act? Humans are the mature result of millions of years of evolution and we only function halfway well because of an enormous investment in cultural, organizational and medical systems designed to control our actions and compensate for our faults!"

"What'll happen to Sandra?" Yasmina wondered.

The captain glanced at Kevlin. "Do you think she'll be safe once the power dies and everything goes dark?"

"The macro stuff, probably. I don't know about the nanos. It all depends if they evolved in the direction of viruses that can remain dormant for almost indefinite periods while awaiting conditions to reactivate."

This time the captain grimaced. "We'll have to junk her. There's no telling how some of her internal components have evolved, so we'll probably use an automated drone to shove her onto a trajectory into the sun. We'll have to severely limit or block evolution of nanos on the next model. Maybe not even use them. They're too hard to track if they do start changing. But we can put limits on the macro drones, too. We'll do better next time," the captain vowed.

"That statement probably could've been carved on a substantial number of tombstones throughout human history."

"Next time will be different," the captain insisted.

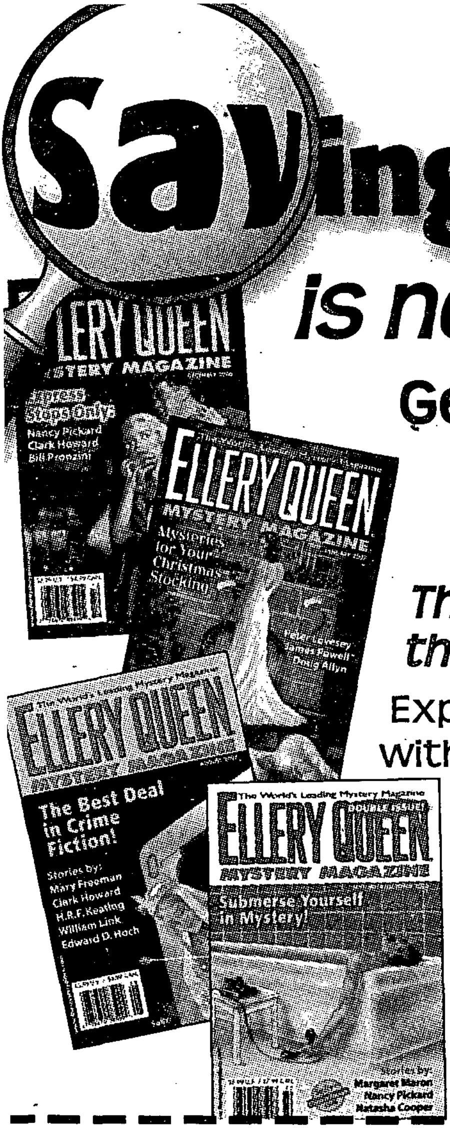
"You're right about that," Kevlin agreed. "Next time *I* won't be aboard."

"Yes, you will."

"No, I won't. My contract clearly limits the duties to which I can be assigned."

The captain smiled. "If you're right, these ships will need medical expertise to identify, diagnose, and treat problems. One of the potential duties listed in your contract is ship's doctor. So congratulations. That's what you'll be. The ship's doctor." ■

> Show me a thoroughly satisfied man—and I will show you a failure.
>
> —Thomas A. Edison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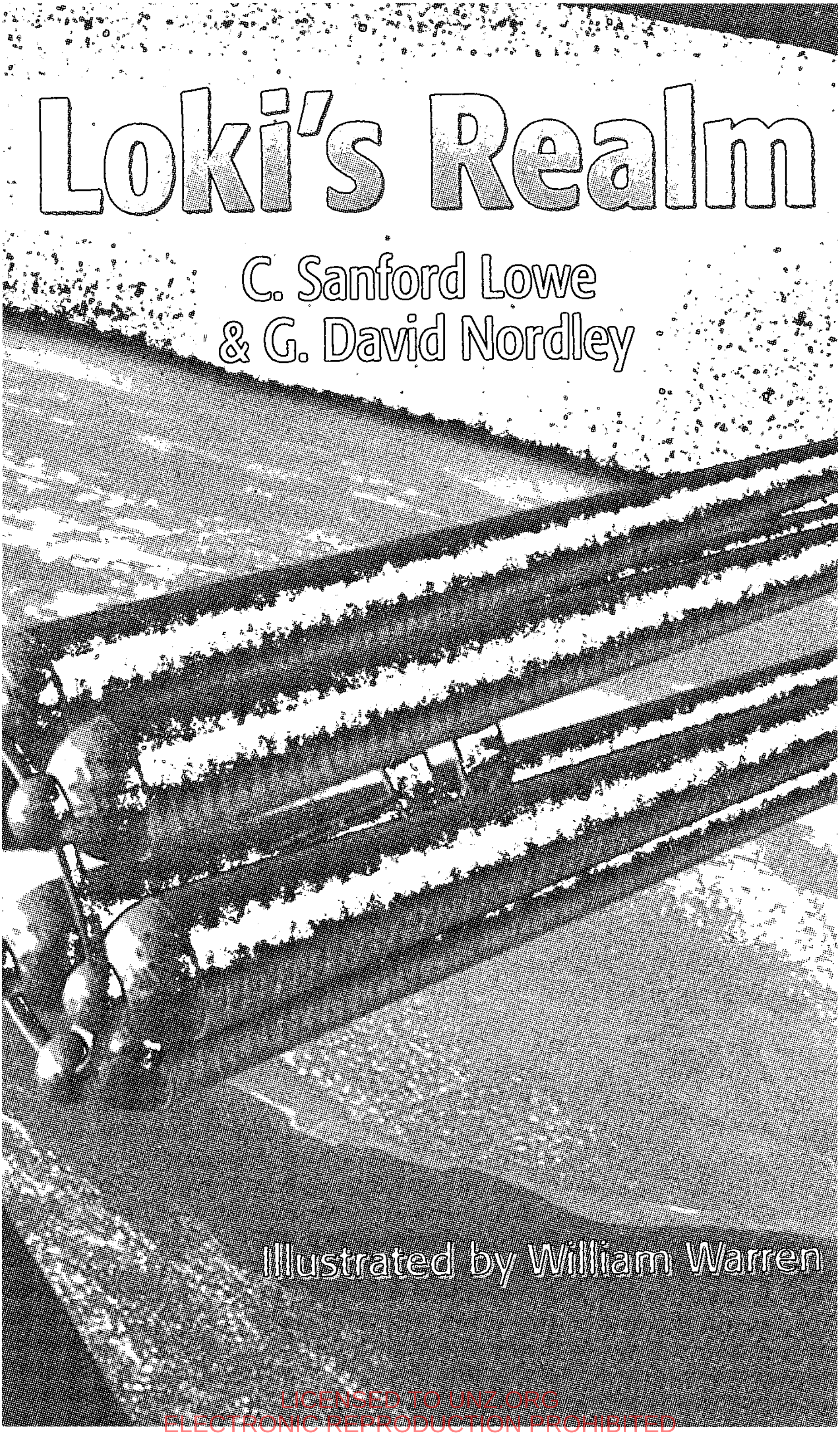

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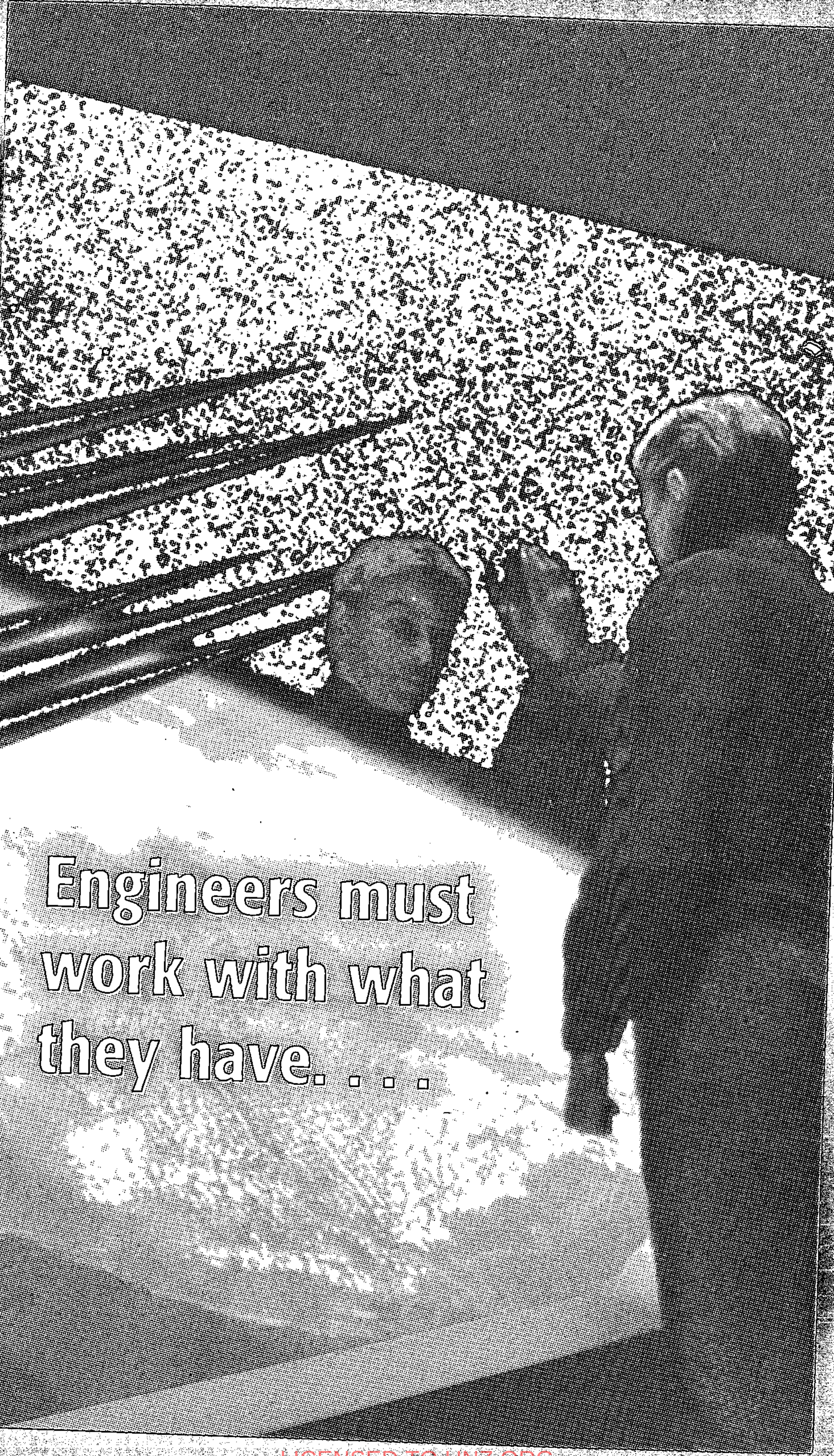
Engineers must work with what they have. . . .

Chapter 1

Broadford, Isle of Skye, Scotland, 12 March 2260

I suppose it's more interesting when, in the words of Robert Burns, "the best laid schemes o' mice an' men gang aft agley" than otherwise. I'll have no quarrel with that, though I do have to say that, had everything gone according to plan, it still would have been quite an adventure. I'm Bruce Macready, historian of the Epsilon Eridani mission to build and launch one of the four impactors of the Black Hole Project.

The idea of the BHP was to accelerate four billion-ton iron-rod impactors from four different stars up to relativistic velocities, then crash them together to generate a pressure at their meeting point that far exceeds what even quantum mechanics can resist, the result being a miniature black hole. Though smaller than an atomic nucleus, it would mass a billion tons or so—enough to stay around long enough for the physicists to play with it and someday, perhaps, use its progeny to construct vast Faustian machines that would manipulate the very fabric of space itself to humanity's purposes.

Aye, that was the hope.

How, you might ask, did a Scottish professor, who had not left the Isle of Skye more than a half dozen times in his 147 years—let alone go into *space*—become involved in this? Well, I had taught the history of science and technology at Broadford College for over half *its* existence, and held every position including chancellor at one time or another. I thought the human race was in a flat place of late, not making history like it had done before. Earth was pacified. Mars was nearly terraformed, and it would be centuries before Venus followed suit. So I sensed that, short of the possibility of alien contact, the BHP would be the signal event of this era.

I found that among the BHP principal investigators was one Bradford Adams, an Australian physicist who had attended Broadford for a year on exchange and had taken one of my classes. Year after year, in explaining our expansion into space, I unleashed the words of Tsiolkovsky to thunder down on Brad and my other students, telling them that one could not live in a cradle forever. Now he spoke to me.

I took it on myself to contact Brad and offer my services as an historian on the fifty-year expedition to Epsilon Eridani—a star about a third of the Sun's luminosity, which, due to its extreme youth, was not suitable for a colony and thus had no indigenous historians. To my great surprise, the project leader, Dr. Zhau Tse Wen, showed up at Broadford to interview me. We hit it off well, and over a glass of fourteen-year-old Talisker, my proposal was accepted. So, with a little more fuss than I need relate here, I made my goodbyes to my older brother, to Macready Manor, to Broadford College, and to my past life.

I sent a few personal things ahead and began this journey of some thirteen light-years on foot, hiking the ten kilometers to Kyle of Lochalsh. One travels light among the stars, and I wanted to savor what little time I had left on Skye. It was October—clear, bright, and nippy—and the view of Skye from the height of the bridge almost made me turn in my tracks and head back.

But no, I have an inertia in me that is legendary, and my path I'd chosen. I sighed and marched down the mainland side of the span and into the transit station. There I caught a fan bus to Glasgow and took an orbital shuttle four hundred kilometers up to Sheffield Spaceport, the rotating toroidal space station near which the starship *Admiral Byrd* was then keeping station.

As I left the shuttle, a smiling attendant met me. "Dr. Macready?" he said. "You're wanted on the starship."

I was surprised; the *Admiral Byrd* wasn't due out for two more days, and I'd anticipated some time to explore

Sheffield Spaceport.

The attendant handed me a pair of somewhat old-fashioned looking spectacles. Smart glasses, I realized. They'd been around for a couple of centuries, but with an old-fashioned wrist comp for all my needs, I'd never used them before.

"They're for those who haven't had bioradios installed," he said.

Of course. I'd been born a wee bit early to have the genetic modification that allows people's brains to send and receive radio waves. The spectacles were a prosthesis for those of us so handicapped, and they'd known I was coming. I put them on with a frown. Nothing appeared.

"Speak the name of what you want to know as quietly as you like, or stare at something for more than a second, down the hall to the shuttle dock, for instance."

I looked at the attendant. The glasses identified him as "Lane Woo, flight attendant, Cislunar Transportation Service."

"Thank you, Mr. Woo. This will take some getting used to."

He nodded with a smile and went about his business as I went about mine. The glasses led me to an elevator down to the 0.1 gee level, through a long park-like transit lounge to the shuttle gate. In a few minutes, a runabout whisked me off to the starship.

Up close, the *Admiral Byrd* was impressively weird. It had a hundred-meter-wide crown of six 120-meter-long icicles that were evenly spaced. At the wide end of each icicle was a ten-meter-radius sphere, which housed the habitable parts of the starship. This entire arrangement rotated majestically. From my point of view, the icicles occasionally eclipsed each other, separated, and eclipsed each other again, making me think of the blades on wool shears.

As I got closer, I could see that the band of the crown that joined them all was thick enough for people to pass through. Closer still, I saw the forward ring sitting about a quarter of the way between the bases and the tips of the icicles. Thin "legs" slanted in and forward to attach this smaller ring to the rest of the ship. That forward ring was a magnetic choke that would increase the ship's ability to reflect the ions that would push it along—the design actually dated back to the twentieth century, though not realized until the twenty-second. It also helped deflect charged debris in front of the ship. It is one thing to study the history of such things, or see them on some video display, and entirely a different thing to see them with one's own eyes. I was awestruck. This was a real starship and I was going to ride on it.

The runabout set down on the inside of the small ring in a complicated maneuver, which its AI handled flawlessly, leaving me with about a tenth of a gee of spin gravity. I wondered if that maneuver could even be attempted manually.

Dock and seal were quickly announced, and the smart glasses guided me down a long, sloping corridor that ran inside one of the choke ring supports to the passageway in the main ring and something approaching lunar gravity. From there they conducted me into the middle of Sphere One, a living room-like common area surrounded by doors to private quarters and a fireman's pole in the center leading to decks above and below. I had barely begun to wonder which door was mine when one to my left opened unbidden. An AI somewhere was responsible, of course.

The cabin was tiny; a fold-down bunk two meters long took up the entire outboard side. A well-disguised lavatory sat to the right of the door at the foot of the bed, and a small desk and chair sat to the left of the door at its head. I checked to see if my personal stores had been stowed, and they had—as part of the shield mass. Included was a precious case of my native island whisky, Talisker. I pursed my lips and set aside my thirst for the nonce.

"Hello, Dr. Macready. Rumor is I'm in charge of this zoo."

I turned. Outside my door was our expedition commander, George P. Weaver, a tall man with close-cropped steel gray hair. By his biography, he was a horseman, a Texan, with Ph.D.s in animal husbandry and systems management. He still had vestiges of a Texas accent, but this was well smoothed toward an aerospace standard English that sounded not too unlike the Canadian of the Toronto region. He offered me the callused hand of a sincere physical hobbyist, with a correspondingly firm grip.

"Glad to meet you, sir," I replied, wondering what he'd think of my rather unsmoothed Scots accent, "and there'll be no need for the 'doctor' so far from the classroom. It's Bruce."

He gave me a long look as if judging whether he was ready to be on a first-name basis.

"Right, Macready . . . uh, Bruce . . . Brad Adams arranged for you to have this stateroom."

"Aye."

"Will you be riding out the acceleration with us?"

Others had described *that* experience well enough for me. "No, I'll be in cold sleep unless something noteworthy happens. Project management's arranged for me to be woken up in that event."

Weaver raised an eyebrow. "Project management will soon be a long, long way away. We'll have ninety-six scientists with us who want to study the Epsilon Eridani system in detail. They're in cold storage and will stay there until we're ready for them."

"I hope my arrangement meets with your approval, then," I added.

His face remained impassive.

"Ah, once I've sorted myself, I hoped to ask Dr. Davra about the finer points of what the robotic minions at Epsilon Eridani can do on their own and what might require our direction." Davra, a comely lass, was the chief roboticist.

He looked at me a bit, then nodded as if making a judgment. "I see you've homed in on the central issue already. The short answer is, their programming *can't* anticipate everything. That's why Doc Zhau sent us."

Dr. Zhau and Weaver had a history that went back several decades, and when Zhau had wanted someone he could completely rely on to ensure the Epsilon Eridani impactor went on time, he'd picked Weaver, as he'd told me over a whisky at our interview.

"Bad luck on Davra, though. She's on ice already." Weaver smiled and gave me a wink. "So you do your research, heed that data, and plan for contingencies. Those are survival traits out here."

I took that as high praise. "Thank you, sir."

"We'll have you on ice tomorrow and you'll wake up in the space colony being built to house us at Epsilon Eridani. So settle in and make your calls today."

I did so, but before turning in, I poked around the ship a bit. If things went according to plan, this would likely be the last I'd see of it.

Chapter 2
Aboard the *Admiral Byrd*, in route to the Epsilon Eridani System, 9 November, 2272

I woke to a low-pitched thrum and a slight metallic taste in my mouth, presumably a legacy of my cold sleep experience. Otherwise, I might have had an afternoon nap. Our trip to Epsilon Eridani should be over, and I should be in some kind of house or apartment in the great rugby-ball-shaped habitat that the robots had been building for us, along with about a hundred other freshly thawed people. Every second or so, I heard a distant hollow thump—a construction device of some sort, perhaps. I was not entirely motionless, but the accelerations were slight; had I not been on a mattress, I doubt I'd have felt anything.

I lifted my head and opened my eyes. The light level was quite low, but enough for me to see that I was still in my stateroom aboard the *Admiral Byrd*.

"*Admiral?* Why am I not in the habitat? Haven't we made it to Epsilon Eridani?"

Do you hear me satisfactorily?

"Aye, but not in my ears! What have ye done to me?"

You've been given an implant. It's a necessary safety item aboard a starship. In a few days, you'll be able to communicate subvocally on the local net, but for now, continue to talk; this lets your chip learn the impulse patterns of the nerves to your vocal cords.

I had just been getting used to the glasses! I blinked hard, shook my head, and stretched to wake myself. Something had happened! I could complain about the surgery later.

You have a message from Dr. Weaver.

"Aye?"

Weaver's voice sounded in my head. *A very violent and entirely unpredicted collision in the Epsilon Eridani system has increased the amount of meteoric debris in the system by three or four orders of magnitude, two orders of magnitude more than the array-building system had been designed to withstand. We will be meeting in the Sphere Three Park at 1400 to discuss the situation and make plans.*

"Well!" They must have known this for some time, I thought. So much for my arrangement. "Let's see what's out there. Forward view."

I saw a glowing Medusa—a black disk surrounded by curling wavy streams of light. It took me a few seconds to register what I saw with what I knew.

"We're in the shadow of this habitat?"

Yes, the *Admiral* answered. *The outward end of the shell has been covered—that is the black disk. I can amplify it if you like, but it is smooth and featureless at this magnification.*

"Never mind. All those streams?"

Those are comets. There are 973 of them in your field of view.

"They're all heading right into the star?"

That is mostly perspective, the AI answered. *Only 311 have perihelia within the photosphere. All but fifteen of those are actually ammonia-saturated slag balls from our mining and solar power station construction operations.*

The *Admiral*'s comments notwithstanding, I was in awe of this picture, of all this cosmic debris falling toward the star, and feeling not a little uneasy. How did the artificial intelligences building the array cope with this? What plans should we make? Was the project itself in jeopardy? I got myself up to speed as much as I could.

Then it was time to go to the Sphere Three Park. Getting there was no problem: the hollow main ring led through the center of each sphere. A woman by the name of Jill Davenport, head of biology, soon followed me on the pole and assured me this was the way.

As I came up the pole I was greeted by a shapely lass wearing a glossy purple shipsuit that looked as if it had been painted on her body. It had a white shoulder-to-hip band, broken by a triangle of well-tanned skin nearly down to her navel.

"Hello, Dr. Macready."

"Dr. Davra, I presume?"

She smiled and motioned to a spot on the grass. "We're about ready to start."

I nodded, sat down on the grass like everyone else and looked up at displays of comets and collisions spread all over the dome.

"Damn it, Emma," Weaver said at length, "how'd this happen?"

Emma Lewis, our astrophysicist, stood up so she could see everyone. She reminded me of my kindergarten teacher so many years ago, save for a London accent. She was dressed, much as I was, in plain walking shorts and a loose pullover tunic that gave little hint of any figure.

"Bad luck, isn't it? The big collision followed a bolometric luminosity spike of almost twelve percent—a huge flare by solar standards—that occurred the year we left. This flare increased cometary activity, causing more random nongravitational accelerations. That caused changes in previously settled orbits, increasing collision rates which increase debris, which increase the number of collisions, and so on. It's a feedback process—exponential as long as a reservoir of material exists; and the giant planet Loki's eccentric orbit continually stirs things up. But a collision that big might not have happened for tens of thousands of years. Instead, it happened now."

"So, what do you think we should do about it?" Weaver asked.

"Study it for now," Lewis answered, somewhat hesitantly. "Something is going on we don't quite understand. We'll come up with a better solution when we do."

"Meanwhile, we're losing ground," Davra complained. "Simulations show the response of the AI systems is to divert power array production to beam drivers, up to the point where that's all that's being made. Without replacement array panels and any new arrays, we'll be falling behind. We'll need to do some creative thinking."

She was answered by a tall, angular, light-skinned man with a shock of dark boyish hair falling on his forehead. After a moment's cobweb-cleaning in the cold-sleep-dusty cells of my memory, I recognized Dr. Daggert Dickson, an engineer, expert in propulsion systems.

"The AIs won't? I thought these systems were fairly creative," he said.

"We constrained their creativity," Davra responded. "We didn't want them thinking up new purposes in a thirty-year management control loop. . . ."

"Oh, of course not," Dickson agreed. "If we don't watch out they might invent sex. . . ."

"Humpf," Weaver interjected. "Well, our starship isn't under any such constraints . . . on creativity that is. *Admiral,* do you have any ideas?"

"The current system is already at an optimum factory-array production balance. It would lose ground under any change in allocation of manufacturing effort. Therefore, to complete the project with the planned performance margins, the current system will need to be changed.

"There are three things being produced: factories, array panels, and beam drivers. One change would be to add something else to the system. That additional thing would need to attenuate the debris flux. One could build spacecraft to find and divert collision fragments before they come into range of the impact-protection systems of the arrays. This would enable the array system to grow again, but not fast enough. However, you asked for ideas, not solutions."

Dickson chuckled. "Thanks, *Admiral.*" He turned to Lewis and frowned. "Look, the composition of the collision debris appears to be mainly S- and C-type asteroidal material, right?"

"Carbonaceous chondrites. True."

"Okay. They're rocks, like the raw material we're using for manufacturing. *Admiral,* what if we collect that, instead of going after more inner-belt asteroids? That takes more propulsion, but we'd be able to put less effort into mining and get kind of a two-fer."

"That was a good idea, Dr. Dickson," the ship said.

I frowned. AIs are programmed to praise humans because it makes them seem more human themselves. However, in practice, I've always found the effect a bit cloying.

Lewis sighed. "Of course it was, *Admiral.* And so was yours. I liked that."

"Why don't you ask him what he's doing tonight?" Dickson quipped.

Everyone laughed except Lewis, who simply pursed her lips and waited for it to stop.

Weaver held up a hand. "Okay, Davra and Dagger, can you get together and polish this off? Give us a look tomorrow morning?"

Lewis looked as if she wanted to say something, but held off when Weaver turned to her.

"And now," Weaver said, "for those who haven't met him yet, I'd like to introduce our captive historian, Dr. Bruce Macready, late of Broadford College, Isle of Skye, in Scotland."

Davra sat up and looked right at me and smiled so come hither she might have been a sophomore in danger of flunking a course she needed very, very badly. I'm not sure what my facial response looked like to her, but, so help me, she giggled. I took it to be a friendly giggle.

Lewis also looked my way, expressionless except for a slightly raised eyebrow.

Dickson shrugged and said, "Hi, Bruce, call me Dagger."

"Greetings, everyone."

And that was that. We all stood up and chatted with each other for a while. Whether by chance, natural reticence, or intent, Emma Lewis was the last to greet me, and by the time we'd exchanged pleasantries, the others had left.

I suddenly realized I was ravenously hungry. "Cold sleep, apparently, gives one an appetite. I thought I'd head to the canteen. Would you like to join me, Dr. Lewis? You could explain again to me just what's happening in the Epsilon Eridani system."

She looked at me as if I'd said something exceedingly strange, but then said, "I don't know that I'll be able to take you much beyond the background material you've already studied, but . . ." She shrugged and gave me a slight smile. "I'm hungry, too."

Once our canteen sandwiches were devoured, she asked what had been bothering me.

"A great amount of planning has gone into this. So much so that a problem of this magnitude seems inconceivable."

Lewis nodded very seriously. "The system has been studied, modeled, and monitored for over two hundred years, with increasing accuracy over time. What happened was unprecedented. I suppose we have to remind ourselves that two hundred years is a near-infinitesimal part of the life of a star. But that doesn't make me feel much better."

"Oh, it would appear to be a serious matter, but I dinna think it one for which you should bear any particular blame just for being an astrophysicist."

She shook her head. "You don't understand. I led the modeling team. It was my call, my assurances . . ."

Och! So it did weigh heavy on her. I am not sure how to explain what I did next, other than that Davra's display had put me in the mood. Davra herself seemed clearly untouchable to me. Those subtle things that sort us males from alpha to zed had made clear to me from my wee years that women like Davra belong only to the alpha sort. To assume she was other than untouchable would only invite heartache. But Lewis was more like another professor, of similar disposition to my own, I thought. And she seemed clearly unspoken for and in need of some friendship. So I had motive and opportunity. Alas, I had also the means.

"In that case, bonnie lass, you'll be needing a wee bit of fortification. Now, have you ever tasted the whisky of my native isle? It is called Talisker, and I have brought a supply with me."

"Whisky? I'll have a bit of wine now and then, but . . ."

"It is only technically whisky. Really one consumes it as a liquor, or a cordial. There's a touch of sherry to it, some say, and a thickness and a sweetness that will put you in mind of no whisky you have ever tasted before. You really must try some."

She gave me a wan smile. "Dr. Macready . . ."

"Bruce," I said.

"Bruce," she echoed, "Call me Emma. I'm 123 years old. Been around the block, haven't I?"

The way she said it, I didn't believe a word of it. "Then come along, lass, will you?"

She laughed a bit. "Oh, why not?"

She followed me out of the canteen. "How did you happen to come on this expedition?"

"I knew someone on the project and I asked. To my surprise, I seem to have been the only one to have this idea." We'd reached my stateroom and its door glided open at my approach. I gestured for her to precede me, then put a scene of Loch Ness on the wall across from the bed, a sunny day in late October full of autumn color.

Emma sighed. "So whatever errors I make, whatever consequences my mistakes have, you'll be there to record it for all eternity."

They dinna send idiots out to the stars. "Now, lass, I'm a fair man. Besides, for such inquisitions there would always be the official logs. My job as project historian is to make what all happens comprehensible to the general reader. I'll not be passing negative judgments on people just because they're people."

She simply looked at my view of Loch Ness. "You mentioned some local libation?"

I smiled, glad for the change of subject. "I did indeed. Talisker, a single malt Scots whisky." I explained about aging, sherry cask wood, local grains and all, as I poured us a finger each.

She took a sip. "Bruce, I can detect very faint echoes of some of the qualities you mentioned, but my overwhelming impression is more of . . . of some kind of mouthwash. And my mouth burns." She gave me a kind of wry little smile. "But it does make me warm."

Her first reaction to Talisker, alas, was an all too frequent one for a novice to Scots whisky. I put my hand on hers and sighed.

She made no move to remove it, but only shook her head. "I'm not sure what's gone wrong. Epsilon Eridani is a very young star system, and it's suffered some recent pathology. The planetary orbits haven't settled down; they're still eccentric and migrating. So it's very hard to tell what happened, or when. A passing star or rogue planet may have disturbed the system. Or the system may be disrupting itself chaotically."

"Disrupting itself?"

She shrugged. "Orbits evolve. Planets perturb each other. Eccentricities vary in cycles. A system may clank along alone like that for millions or even billions of years, then someday all the cycles match up the wrong way and two planets come too close to each other and there is a brief gravitational embrace, one gets ejected and the other moves inward in an eccentric orbit. Then they settle down, like Uranus, Neptune, and Pluto in our system. But it takes billions of years. In this case it's Loki swinging wildly in and out, flinging planetesimals out of the protoplanetary disk with its gravity at both ends." She drained her glass. "This stuff does grow on you."

I poured another round.

She raised an eyebrow at me. "Must remember I'm on the record. . . ." Somehow she had moved near to me, her arm lightly touching mine.

It burned where we touched, in a way I remembered from close dancing in the days of my youth. I mulled over whether she might welcome an invitation to become more intimate, or whether that would be too forward for now.

"You're a professor of history?" she asked.

I nodded and brought up pictures of Skye, Broadford, Portree, and the family on the wall screen.

It was then that the terrible reality of what I'd done hit home. "It's just been a couple of days to me, but they've not seen or heard a thing from me for over a dozen years now. Like that star system you describe, all of a sudden things come together, then, boom, I'm off into the cold dark. History can be like that, do you know? The lives of those who have done things of note oft get a bit messy in the process. But I left no other complications behind."

"Me neither. If you think about it, that's probably true of most of us on this mission."

"Davra?" I asked.

Emma rolled her eyes. "I'd guess life is *very* simple and uncomplicated for people like her and Dagger. No need for anything deep or long term. No need to waste time. She can get what she wants out of any man. So we off and do something when we don't really know what we're dealing with."

"Maybe you should have a talk with Weaver, privately."

"We call him G. P., Bruce." Emma looked into the bottom of her cup, then gave me one of those subtle but suave know-it-all looks that the English are so good at. "It's too late. Davra's already persuaded Dagger to go for her robotic solution and G. P. goes with a majority."

"He has no view of his own?" I asked.

Emma nodded and took another sip. "He can be disengaged at times. He's a widower—his wife was thrown from one of his horses. Awful thing and I imagine he blames himself."

"Aye, that's a hard thing to get over."

"Isn't it? This star will likely settle down and stay that way for twenty billion years. We don't die of natural causes anymore. So he may still be blaming himself twenty billion years from now."

I shook my head, raised my glass, and smiled. "If in that time he dinna fall off a horse himself."

Emma laughed slightly "The universe, I think, needs some stable people in it. Those that don't fall off horses."

"Aye."

We sat for what must have been minutes not saying anything, then she sighed and stood up. I missed the touch of her arm immediately, but couldn't think of a thing to do.

"I enjoyed this, Bruce. We should talk again some time."

"It's been a good conversation, yes." I stood up. There was no walking her to the door, as it was only a meter or so from us. So she simply walked out the door, it closed, and I sat back on my couch. Two minutes ago a real woman had been sitting next to me ready for anything as far as I could tell, and I had not as much as put my arm around her. Sadly, such was typical of my history to that time, if the truth be known.

I noted that we'd done in a quarter of a liter. With several years to go, I'd need to be a bit more parsimonious from here on.

The next day, Dickson and Davra's plan was adopted with a few technical modifications. I had several more conversations with Emma, all in public places. I felt awkward and the contacts grew less and less. Meanwhile, I learned how to "touch the net," to ask for information and send messages to people. I'd been perhaps too aware of the fears of how such communication would change us utterly, and was relieved to find them so very unfounded. It was no group mind or anything like that—much more like using a wrist comp without having to raise your arm to look at it or speak to it.

I ran into Weaver at the canteen.

"Morning, Macready. I hear this is becoming your work area."

He said that with a grin on his face the likes of which put you in mind of a brilliant morning sun chasing the mists away from the bay at Portree, that or twenty-year-old Talisker. He affected some rustic crudeness, but he could cut to the chase faster than Broadford's chancellor did, which was saying something, indeed.

"Aye, I suppose it is. It's a good place to meet people when they're not too busy and pump their brains. Now, since you're here . . . I've scanned Davra's notes on the system feedback loops, and I wanted to fit it into the big picture, from your perspective."

Weaver waved me to a seat and ordered coffee from his replicator. He turned back at me. "Coffee?"

"Tea. Earl Grey with a bit of cream and sugar, if it wouldn't be a bother."

He stepped over to the dispenser. "We're about three months behind where we should be, even with the habitat construction delayed. I reckon it's manageable, but it's worrisome." He had the face of one who didn't need such worries.

"The research crew stays frozen then?" I asked.

"Until that habitat is ready, we've got nowhere to bunk 'em."

"Is there nobody in there with expertise that we might use, say in a brainstorming session?"

Weaver looked me in the eye. "I've got what I think are the best experts on this already. The group is about the right size—I don't want too many cooks. And I definitely don't want any more politics. I also do not want there to be anything to encourage the politics I've already got. Savvy?"

"I think I've been very careful not to take sides, Dr. Weaver."

He looked at me and nodded. "We have a break in the solar weather coming up and Dagger's going to take a looksee at the habitat tomorrow, hoping to get some ideas to speed up construction. You up for the trip?"

I'd not a thought about going off the ship, but the idea did arouse a bit of curiosity in me.

"Huh? I dinna see why not."

"You two might find a thing or two to chat about on the way." Weaver grinned and clapped me on the back. "Let's mosey."

I met Dagger at the lift leading up to the runabout dock.

"You've been spending a lot of time with Emma." He looked at me as if testing to see my reaction.

I was duly taken aback and decided to avoid anything personal, at least for now. "I've learned a lot from her. We watched a big slagheap from the prograde feed path hit Epsilon Eridani yesterday. She's trying to detect any lasting spectroscopic evidence of the impact."

"Like a star spot? The only star spots I know of come from huge magnetic fields, so I don't . . ." Dagger stopped speaking and held up a hand; the lift had arrived. We got on it and announced our destination.

Dagger turned to me again. "Now, Bruce, you gotta keep in mind that this is a relationship with a woman, and there are some things that, well, naturally go along with that. Can't run away from that. Body won't let you."

I shivered at his crudeness but resolved to not play the tyro. "Aye and then not aye. She's a wonderful person, but matches my reserve all too well, if you understand."

To my surprise, he nodded quietly and sat for a moment, thinking. At last he looked at me dead in the eye and said, "So you both wait 'till hell freezes over before either of you makes a first move. I figured something like that. So throw a line in another pond."

"Aye . . . Well, mine has never been all that needy, if ye ken."

Dagger slapped his leg and guffawed out loud.

"We're here. Let's check this bugger out, and I'll tell you all about it."

I found that a bit rude at the time, but he was an American, after all.

The runabouts were stored in the long hollow cones. When needed, they dropped out, i.e., away from the spin axis, flew up, and attached themselves to the docking port at their bellies. To me, the runabouts looked like half a transparent sausage lying atop a small version of Clarke's rectangular monoliths.

A person came in through a lock in the bottom center of the rectangular part and entered the transparent half sausage. There were ten pairs of seats in this cabin, with an aisle down the middle. The ends were quarter-sphere domes. We floated in that way and strapped ourselves in at the front. Despite complete automation, Dagger looked over the boards very carefully.

"Okay, let's go," he said at length. The runabout detached itself, rotated, and jetted out toward the habitat with the slightest of acceleration.

As the runabout approached the mammoth incomplete habitat, I felt like the fledgling leaving the nest for its first trial flight. Yes, I'd ridden in another runabout out to the starship from the station—it seemed like a million years ago now—and that had been exciting enough. But that was really a glorified taxi ride above Earth. Now here was an alien star system!

"Bruce?" I turned to see Dagger staring at me with a big grin on his face.

"Uh... Wee bit new to this, is all. You were saying."

"Just if it's not gonna work with Emma, it's not gonna work. Hedge your bets. Spend time with someone else."

"Och! That would seem disloyal at this point."

"Women, they understand that kind of thing. Sometimes I think that's about all they do understand. Look at this mess we're in. Emma did the astronomy and Davra did the robotics."

"I'll not be traveling that road with ye, Dagger," I said, shocked. "There were many, many other eyes on those plans and most of them men, I'd think."

"But not since we started having problems. Things haven't gotten better, they've gotten worse. I don't think either of them has the big picture. They try to deal with it by intuition, and whatever it is, it's outside their intuition's box."

"Aye, there may something to that. Not that anyone else seems to know either, mind you. I thought of suggesting to our chief that he might be getting a wee bit more help on this, and he nearly bit my bloody head off, so to speak."

"Probably because I suggested the same thing. G. P. is a bit touchy when it comes to critiquing his leadership."

A huge comet tail came into view just before we came around the edge of the half-finished habitat. I couldn't see the coma—indeed, it might have already hit the star. A pebble splashing in the sea, I thought, contemplating the relative nature of violence in the Universe.

The edge of Epsilon Eridani came into view. In a blink, stars and comets vanished as my eyes adapted. The smooth gray surface of the half-finished habitat gave way to a latticework of aluminum beams extending out to where its equator would be. Our shuttle glided around this and finally gave us a clear view of the inside.

"Take us across the diameter, for a first look," Dagger told the runabout. "Then we'll fly back along the surface that's been built so far. Align our roll axis to the habitat sun line."

The runabout performed the last of these maneuvers first, then canceled what remained of our sunward velocity, leaving us nose first to see a "full" habitat. A topography of sorts had begun to emerge. You could tell where a large lake was going to be. I could see the sculpting of the far end—what would become tree—and grass-covered highlands sloping down to the higher-gravity lowlands of its equator.

"Tell me, Bruce, did you bring one of those kilts with you?"

"No, but it would be easy enough to replicate; there are many patterns on file. Getting a bit warm?" The star on one side and the reflection from several square kilometers of unfinished habitat on the other were warming the insides of our transparent bubble rather rapidly.

"Yes, a little. The fans will kick on in a bit. About the kilts, I always wanted to ask a Scot..."

I laughed. "In my case, generally a well-used pair of walking shorts, as I'm not so fond of embarrassing accidents."

Dagger laughed. "Well, you could make an exception for Davra...."

Now *that* was the nature of the man.

"I'd need to know her a wee bit better," I replied.

"She hasn't made a move on you yet?"

Dagger seemed astounded.

"No. I'm not very tall, my voice is a bit high, and I tend to lecture, so it's no surprise."

"Hmm. She has a purpose in life and she knows what it is."

"She's an excellent roboticist."

Dagger shrugged. "That too."

"Emma seems more my type."

Dagger laughed. "Coward! Emma makes love like she writes a scientific paper. Everything precise and in its place and a soft little squeal if she gets something out of it. I asked her once what would happen if she let go. She said, and I think she meant it, that she *was* letting go."

"You've been intimate with Emma? I dinna . . ."

As so often happens, when you discuss someone, they pop up. The ship's attention tone sounded again and there she was on the console screen. She could not have heard our discussion, I had to remind myself, but guilt must have been written all over my face!

"You look as if you've swallowed a canary, Bruce."

"Good day, Emma," I said.

Dagger waved at the video pickup.

"The habitat looks an awesome sight from where you are," Emma said. "Pity we haven't finished the other half."

When finished, the habitat would provide a decent living space once the rest of the passengers were defrosted. While our crew's work would be done in a few years, the people who'd come to study the star system might remain here for decades, perhaps permanently. The full kilometer from the center to the empty half-finished bed of the equatorial pond was a very impressive sight.

"Real estate," Dagger said. "I'm looking forward to making some wings. Maybe have the robots make me a little split level on a riverbank. You should see the slobber marks all over the canopy. Getting hard to see."

"You'll find serviettes in the mess module. Now, there's a new prediction of particle flux hitting in about two hours. It might be more than the runabout can handle, so Captain Lee wants you both back at the ship before then."

"Uh, right." Dagger said. "Tell her I plan to be back aboard and on my back in bed by then. Unless, of course, she prefers it some other way. . . ."

"Message received, Emma," I said. "Thank you."

"Cheerio."

"Let's hang out here a while," Dagger said. "I want to pick out a place for my geraniums."

"Deceleration in three seconds," the AI announced. "Two, one . . ."

A soft *thonk* and a lean to the side announced the maneuver.

The inside of the habitat reminded me of a cleaned-out eggshell—almost that white—with the ragged latticework of the equator serving as the rough edge of such a shell.

"Impressive bunch of real estate," Dagger said.

A sudden *snap* got my attention. With no more warning than that, miniature lightning bolts began to jump from place to place across the control panel, between seat frames, and even off my fingers toward anything remotely conducting.

"What the hell?" Dagger exclaimed.

"Emma?" I called.

No sound.

Dagger gave me a quick look that said trouble. "Shuttle, what's our status?"

The AI said nothing. I looked over the instrumentation console. The screens were as gray as a November morning fog on Skye.

"I think we're looking at a real power loss here," Dagger said in measured, professional tones that did nothing to disguise the tension in his voice. "Ouch!"

I felt a surge up my spine. Electricity or fear, I knew not.

Gradually, the fireworks subsided to be replaced by dead silence.

"Have we been hit?" I asked

Dagger shook his head. "Didn't feel anything like that."

"They'll miss us, right?"

I could see Dagger's face reflected off the canopy. He was scanning the boards, looking for anything.

"Yeah, they should. If they're okay themselves. Looks like a complete electrical failure here."

"What does that give us?" I asked quietly.

"Well," Dagger scratched his head. "The good news is we're alive with enough breathable cabin oxygen for thirty minutes or so. The bad news is, we can't hang here. Notice it getting hotter? Reflection, I'd say. Getting insolation from both sides."

Our shuttle had begun to tumble. "Can we get away?"

"Maybe. Let's get our emergency suits on. They've got a cooling system that's body-movement-driven, a marvel of fluidics."

I found the cabinet—marked EMERGENCY in big red letters—pulled the panel away, and grabbed the suits. "Helmets?" I asked.

"Not yet, but let's keep them handy. Gotta move this thing somehow."

"Fluidics . . . Dagger, if I remember properly, there are valves . . ."

"Yeah, of course." Dagger dove for a panel in the floor. "Can you pass me the tool kit?"

I found it and gave it to him. He squeezed himself under the floor. In a few minutes, punctuated by groans and expletives, he bellowed, "Hold on to something!"

I grabbed a seat. "Holding."

There was a kind of boom and we jerked up. I almost fell.

"I think I've found the plus-Z peroxide feed. Now, what you'll need to do is look straight up and tell me when the edge of the habitat is overhead."

"What part?" I asked.

"Any part!" he yelled back.

"Aye, I hear you." I looked up. It seemed to take forever, but eventually our slow rotation precessed to the point where the unfinished edge of the habitat was overhead.

"I've got an edge overhead now," I said.

"Hang on."

I did so, and this time there was a sustained push for maybe two seconds.

"What's happening?" he asked.

It was hard to tell how much movement we got from it by eye; but I did notice something. "We're spinning faster, and it's getting a bit cooler," I said. "I'd say we're off dead center, so to speak."

Dagger groaned.

"Well, I dinna think it was that bad."

"No, damn it, not you. I've lost the wrench."

"Och! Well, at least we are moving."

"How close are we to the habitat wall?"

We had moved noticeably. It was hard to judge by eye, but it seemed as though we were twice as close to the side toward which we were moving as to the other side. "Maybe seven hundred meters and closing," I responded.

Dagger emerged from the hole in the floor. "Can't find it. How are we doing?"

"Maybe six hundred meters, now—that done in about a minute," I said. "About twenty meters a second or so. We should be there in about six minutes."

Dagger and I watched the habitat get closer and drift slightly off to the right. "I don't think we're going to hit it, Doc," he said.

"Well, a bit of good news!"

"That's not good news. Without power, this runabout is a death trap. If someone doesn't rescue us, we've gotta get some mass between us and that particle storm before it gets here." He pointed at the habitat. "That mass."

Epsilon Eridani rotated into view. It was covered with ominous spots. The runabout's air was beginning to smell sweaty and stale—the canopy was large, but would contain only so much oxygen. I thought about all the years I'd spent at Broadford and the inexplicable humor of a cosmos that might end me so far from the Isle of Skye.

"How are we bloody going to get there?"

Dagger looked at me like a man possessed. "We'll have to jump for it. Grab your helmet."

It looked a bit chancy, but it was clearly the only choice, and one that was fast approaching. We got our helmets on and began to check each other, as the manual called for.

"Bet this is as fast as you've ever had to do this," Dagger said as I inspected the neck seal behind his head.

"Easily, but that would be unfair."

"How so?"

"Well, laddie, this would have to be the fastest time for reason of it being the only time."

Dagger sounded for a moment like he was choking, so much so that my eyes went to his air hoses with concern.

"Doc, there's no orange showing on the seal, is there?"

"None at all. I did read the manual."

"That's a good thing . . . a good thing. Well, Doc, do you happen to remember where the manual canopy bleed is?"

I thought for a moment, calling forth a fuzzy image of the schematics in my mind; but I could not see it so clearly. My memory of text has always been far superior to my memory of images.

"Sorry, I cannot. Why don't we just go out the lock?"

"It needs power, Bruce."

"Oh." Of course it did. "Uh, how *are* we going to get out?"

"There's a canopy door for use inside the habitat. It opens in, so we've gotta let the air out first, otherwise we'll never be able to pull it open against the pressure."

"Oh."

Our rotation brought us around to a close-up view of the habitat's edge.

"Jeez, we're almost there." Dagger flipped upside down and started working on the base of one of the runabout's chairs.

"Dagger . . ." I had no idea of what he was doing, and we had to get out of here in a couple of minutes or be fried by the particle storm. Some anxiety must have slipped into my voice.

"Stifle it, Bruce, and grab this chair so it doesn't float away."

Having no idea what he intended, I did so. Then the chair came free and he flipped back, feet to the floor.

"Now hold on to me. Use my backpack harness."

I grabbed it with one hand and a still-attached chair with the other.

Holding the backrest of the chair with both hands, with a mighty heave, Dagger swung its titanium legs into the canopy. There was a satisfying crack. He did this again, and a small crater appeared in the transparent cover. Two more swings and there was a slight pop and a noise like a balloon deflating. Necessity is indeed the mother of invention.

We were almost even with the girders of the habitat.

"Come on, give me a hand with the door," Dagger said, his voice noticeably fainter.

We both pulled the hatch in as hard as we could. Finally it moved. Air rushed out past me. We pulled harder and it swung open. The remaining air blew out with a ghastly whoosh as I hung on for dear life.

Our emergency suits had kits with dispensers of what looked like brilliant orange cloth measuring tape. Dagger pulled a tape from his suit and attached it to mine.

"If one of us catches on, we both do. Get ready."

Our rotation brought the habitat's bare frame in front of the hatch.

Dagger pointed to a girder. He mouthed, "Jump!" I braced my feet on the doorjamb and leaped at the girder. Dagger jumped a bit later, before the tether between us went taut.

Terrified, all I could do was reach out and hope to find a grab-hold. It took forever—we were farther away and the structure was bigger than it had first seemed. I closed in on the girder, finally saw a crosspiece come within reach. I grabbed it like a monkey and held as my feet swung to the frame. I gasped with relief, then looked back.

Dagger floated toward me, arms stretched out waiting for a girder, but none came within reach. Then the tether between us pulled taut, and he swung onto the girder feet first like he'd been born to it.

He tethered us both to the girder, then pointed at our runabout tumbling away into space. The escaping air and our jumps had propelled it away from the habitat at right angles to its original motion, slanting away off to our right. There, save for some very good luck, went I! We allowed ourselves a minute to catch a breath.

Dagger touched his helmet to mine. "Radios don't work. Life support's on a body-powered fluidic backup—it's limited, so take it easy. First time EVA?"

"Aye."

"Well, better us rather than the girls. Kinda hard to imagine them coping, isn't it?"

"Oh, I dinna know, Dagger. Wreck the boat and get themselves stranded on a bunch of bare girders waiting to be fried by a particle storm? Och, that they might have done."

Dagger guffawed so hard his helmet came away from mine, and I was treated to what looked like a silent movie of a man in convulsions. Finally he calmed down and looked around.

I did as well. Our only immediate protection was the junction of two girders—maybe a square meter of shadow space. The silence was deafening, and through it came a fast beating of my heart. At least I'm alive, I thought.

But for how long? We'd had two hours until the particle storm was due to hit, but no telling how much of that was gone with the chron on my wrist inside the suit and the suit's electronics out.

We were probably going to die anyway. I was going to miss out on half of the biggest adventure of my life. And then where would I be? The chronicle would never be finished. It was the one thing I'd wanted—a book of my own about something really important. With a bit of time to think, I'd quickly gone from relief to profound regret.

Dagger touched helmets again.

"Gotta get in the shadow . . . should be able to see the starship . . . only a couple of kilometers."

"How?"

"Leap-frog. I'll skim on ahead and out on the tether. You stop me and I should swing down to the surface. I'll tie down there, then you release and jump out. The line will swing you back in an arc and you'll land ahead of me—be sure to land feet first. Then you tie down and I'll do the same thing."

"Aye, I understand. Any idea of the time?"

"Thirty minutes to the particle storm arrival, maybe. Didn't think to take my watch off before I put the gloves on. Well, I'm off. I'll pull on the line a couple of times when I'm ready for you."

I watched carefully as he jumped over the unfinished habitat latticework toward the portion that was solid and might provide more protection. After some time, the line went taut and he swung down to the surface.

Then the line jerked twice. My turn. I found I could grab an edge of the beam with each hand and assume a kind of squatting position. Then I just let go and stood up; that got me going as fast as I wanted. The tether pulled taut in a second or two, and I swung forward over Dagger and down toward the habitat. With some doing, I was able to get my feet "under" me again.

As I descended, I realized I would miss anything solid and "land" in a gap between the beams. Judging the matter as best as I could, I pulled on the tether tape to bring me down a little closer to Dagger, where there was a solid girder. I missed with my feet, but was able to grab it with my hand as it went by.

Whew!

I tied down, pulled the line twice. Dagger made his jump, with much the same results as the first, except that he vanished near the end of his swing—we'd reached the shadow of the habitat.

I took another jump, swung down, and went blind as I entered the shadow before my eyes had adapted. I bounced in the dark and floated out, helpless. Dagger reeled me in.

We touched helmets. "Gotta absorb the impact with your legs. Shit, pull the protective covers off the geckro patches on your boots!" Dagger said, showing me the gray circles on the bottom of his space boots. Normally the geckro patches—areas of artificial nanofibers that cling to things in space like the microscopic hairs on gecko feet—are protected by special plastic covers so the boots don't stick to everything.

"Och. I dinna think of it." I quickly reached down and pulled them off. Memory is a tricky thing. There's a fine difference between knowing something, and thinking of it under pressure in unusual circumstances.

"Yeah. We're on the completed part of the habitat shell now. There should be a line of handholds every ten meters," Dagger said. "Latitude and longitude—it's a standard safety feature on the outsides of these things."

Latitude and longitude, I realized, referred to the habitat's outer surface. The "north pole" would be the completed end of the half-egg shape, with longitude lines running from it, and latitude circles at right angels to those. I looked around but was unable to spot anything.

"Bloody hard to spot. They should have lights."

"They do." Dagger said. "But there's no power yet. Where the devil . . ." he complained. "Bruce, move your foot."

I did so, and there, right under it, was a hand-sized depression with a small bar running across its diameter.

Using the handholds as tether attach points, we were able to continue our journey. Soon we saw the starship rise over our tiny horizon. As the rising was due to *our* motion and not its, this event was not that much of a comfort.

"I'm exhausted," Dagger said. "Need to rest."

"Right." When exercising, the CO_2 built up faster than our body-powered back-up life support systems could handle.

After a couple of minutes, Dagger said, "Look, I got an idea. We take a Mylar blanket from the emergency kit, jump out into the sunlight, and use the shiny side to reflect a bright spot down on the habitat. The *Admiral* should see it moving around and tell someone."

"If it's still functioning." I was in a gloomy mood. "And if the someone doing the reflecting doesn't get fried when the particle storm gets here."

"Hell, Bruce. Sometimes you gotta take a chance."

"Aye." I fumbled the kit open, pulled out the blanket, and flattened it. I could see stars in the reflection of the shiny side. We touched helmets again.

"It should work," Dagger said.

We gave it a try. It seemed to go well enough; we didn't feel like we got fried and a bright spot of light danced around on the shadow side of the habitat. Then we pulled ourselves back down to wait.

The conversation, as such things are wont to do, worked its way around to the women. "Let me see if I understand," Dagger said after I tried to explain my unconsummated friendship with Emma. "It's never got that far with Emma, or with anyone?"

"Look, it's not as if I'm gay or anything like that. I'd be quite willing under the proper circumstances, I assure you. It's just that every woman I met was a student or a married professor or a colleague with whom I would not want to embarrass myself, or too dull to interest me, or . . . och, I don't know. Look, Emma may need a little more effort than I'm ready for. Anyway, there is no hurry, these days."

"She's a bit of a cold fish at times—just needs some leadership. But Davra now. She takes charge, more than even I can handle sometimes. Of course, maybe that's her real purpose."

I winced at his rough assessment. "Aye, with the robots and AIs taking care of themselves, she wouldn't really have that much else to do."

"You should give her a try."

I winced again, this time for Davra. "I'd not be her type, I assure you—sophisticated things are beyond my imaginings." I could adore her from afar, but actually having to contend with her experience might be an exercise in humiliation.

"I have some video files," Dagger offered. "Training material. I dated this girl once who starred in . . ."

"I'll pass, thank you. Look at these stars, now. I've never quite seen a sky like this." My eyes had fully adapted to the dark, and the Milky Way was right across my field of view, but much brighter than I'd ever seen on Earth. And it was repeatedly crossed by comet tails every bit as bright as it was. Some were long and thin, some double, some fans of gold light.

"Yeah, you're right. Even wall screens don't do it justice. Not enough field of view. God, look at all the comets. And all the space junk; half the stars in the sky look like they're moving, like we're near some kind of airport."

I shuddered and broke contact. Those weren't airplanes moving at a few hundred meters per second; each slowly moving point of light was the size of a mountain or larger and moving hundreds of times as fast. And one of the stars seemed to be getting bigger, or brighter. I bumped Dagger's elbow and pointed at it. We touched helmets again.

"I see. It's not moving. Just getting closer," he said.

"That means it's going to hit us, doesn't it?"

"Yeah. It's coming right for us. Too bad about the habitat. Too bad about everything."

"We could jump."

He shook his head. "Hang onto something big and solid. Half the chance of getting hit by shrapnel after the breakup."

I grabbed a handhold and watched in silence as the oncoming object suddenly vanished into the shadow of the habitat. My eyes adjusted and I thought I could make out its black shadow against a comet's tail. Is this how it would end? I thought bitterly. Would our hopes be dashed by a futile spot in the sky?

A brilliant light suddenly exploded around us. I braced for the shock.

Dagger's helmet bumped mine. "Hang on, Doc, it's another runabout with a searchlight!"

"They've come for us then?" My eyes adjusted and I could see the dark shape of the space vehicle with Davra's lovely face lit by light from the controls. In that moment, life seemed wonderful and Davra particularly so.

Positioning jets spit from the side of the little craft as it slowed, swung around, and gently drifted down to us.

Dagger bumped my helmet, laughing. "Our limo has arrived."

We stood up just as the airlock in the bottom of the little runabout opened up. Emma, bless her, motioned us to jump in and we did. Never had a wee bit of ship's noise sounded so good.

Topside, we pulled our helmets off. Emma's face could have been the model for the *Mona Lisa*. She motioned us toward the seats.

"You have the most beautiful face I seen in the last three hours!" Dagger said, grabbing her for a big kiss. "I can't believe we're alive!"

"Emma, Davra, what the bloody hell happened?" I asked.

Davra turned around and shook her head. "We got a major electromagnetic pulse when the coronal filament loops collapsed just before the flare. The half-finished habitat acted like a parabolic mirror. Every wavelength over a centimeter came right back at you, several million times stronger."

"But we weren't in the exact center!"

"Neither was the pulse in the center of Epsilon Eridani's disk! Probably ten thousand kilometers above the left limb. We'll go over it all later, but first we've got to hurry back to the ship before the particle radiation storm hits."

"Buckle up," Davra said. "*Admiral*, get us out of here!"

The shuttle reacted as if an unseen hand grabbed us and threw us at the starship. The *Admiral* began to grow larger ahead of us.

"Uh, Davra, Emma, thanks," I said.

Davra turned and gave me a smile that would take the mist off a moor, but there was a bit of cat-that-caught-the-canary to it. "Sure, Bruce. A piece of cake! You guys gave us a bit of excitement out there!"

"The particle flux has arrived and is increasing," the *Admiral* told us. "Ten millisieverts a second now, lethal levels predicted in approximately seven minutes."

"Is this as fast as she can go?" Dagger muttered. "Where's a fast woman when I need one?"

No one laughed or said anything. We kept looking at our wrist comps as the *Admiral* grew from a toy to a full-sized spaceship.

A hundred millisieverts a second. Somewhere I remembered that a prompt dose of fifty millisieverts was fatal—I could take about a hundred seconds of this. But the ship filled the sky. About six hundred meters from the ship's center, the *Admiral* announced, "Two millisieverts a second."

"Home free, pretty much," Davra said. "We're within the ship's magnetic field. But it would be better to get down to the spheres where we're behind some water."

The runabout glided neatly onto the docking attachment with a satisfying clank. Air whooshed into the airlock.

We were greeted by Jill, who hurried us out of the lock toward G. P. Weaver, and a very tall East Asian woman with dramatically long hair, wearing a simple black jumpsuit. Her face seemed familiar, but my European-trained eyes couldn't place her for certain. She asked how we were, seemed satisfied, and then told us very gently that we would not get many second chances out here. She looked at Weaver the way a disapproving parent would look at a child, shook her head, and left. I'd thought she was the ship's physician until I'd gotten a clear look at the nametape on her jumpsuit. Despite over a decade of being no farther from her than the length of a football field, that was the first and only time I met Captain Lee Hyun Sil face to face.

"Let's get downstairs," Weaver said.

Tension drained from me as we entered the Sphere Three Park area. I turned to Emma. "You saw our light spot, then?"

She looked at Davra. They giggled.

"We had a better homing beacon," Emma said. "Uh, 'cold fish,' I recall."

"'. . . wouldn't really have that much else to do . . .'" Davra added.

"'. . . just needs some leadership'?" Emma raised an eyebrow.

"'. . . likely into sophisticated things'?" Davra stuck out her tongue at me and wiggled it.

"Your suit transceivers were fried," she added, "but the microphone preamps worked just fine."

Chapter 3
Aboard the *Admiral Byrd*, In the Epsilon Eridani System, November 2272

Meeting in the Sphere Three Park the next day, we put the banter all behind us.

"We aren't achieving exponential growth," Weaver said. "Between an increasing impact rate and particle storm damage, we're barely achieving any growth at all."

Emma sighed. "Star weather, like all weather, is chaotic. In all likelihood, our best strategy may be simply to slog on and wait for it to get better."

Dagger shook his head. "And when will that be? The impactor should start on its way in less than two years, and we'll need to have the array up to full power within a month of that."

Davra, for once entirely serious, nodded. "We try to optimize for one set of conditions, and the conditions change, with no rhyme or reason to it."

Weaver's face looked grim. "We've got to come up with something, folks. I'm counting on you, along with people on three other planets, not to mention the impact station."

I looked at him. This was leadership, aye. But where were the ideas going to come from? Everyone sat silently.

Well, this was not so different from uncounted faculty meetings. I could at least get a ball rolling. "I'm no technical genius, but if you don't mind some input from a historian, there's an old engineering problem-solving technique called brainstorming. You sit around and throw out ideas, no matter how crazy they seem. No criticism, just throw out ideas; one then suggests another and you record all of it. Then you display what you got, note the problems and maybe solutions to the problems. Those that have no solutions, you winnow out."

"I reckon that sounds like a way to start, anyway," Weaver said. "Let's try it. Dr. Macready?"

He wanted me to set an example, so I thought of the craziest thing I could. "We seem to be fighting a hostile intelligence. Maybe we can communicate with it?"

Emma groaned.

Dagger laughed. "Can't critique yet, if I got the gist of the rules. Okay. Maybe Davra here is in cahoots with all the anti-Black Hole Project people back on Earth and is secretly sabotaging the robots. We fire her and it gets better. We're going round robin on this? You're next, Davra."

She clenched her hands together in front of her and stared down, then took a deep breath. "We don't need the power right now. Maybe we can store everything in one protected place, then unfold it when we really need it. G. P.?"

Weaver seemed surprised at the notion that he would participate in the brainstorming session, but he smiled. "Haven't had to saddle that stallion for a while. Well, now. If we think there may be an optimum strategy outside our search area . . . something extreme . . . Maybe we don't make any more arrays at all, just grow array makers exponentially. Less area to worry about. Then we turn 'em loose all at once." He smiled again and shrugged his shoulders. "Emma?"

She gave a short laugh. "It's an engineering problem, really. I don't recall reading of any similar situation."

Everyone looked at her.

"Oh, very well. Impact damage goes as the square of velocity. So we could start over farther out where the relative velocities are lower and the particle cloud is less dense. We'd use thin film reflectors to concentrate light and make up for the loss of insolation."

We went round and round in this way for an hour. Everyone leaned forward as they threw out their ideas. Good, I thought, as the words flew across the grassy floor of the dome.

I had trouble visualizing the problem, so I asked the *Admiral* for a view of the Epsilon Eridani system and the cloud of debris.

The *Admiral* portrayed the system on the dome ceiling. The debris cloud looked like a fat translucent doughnut, with Epsilon Eridani a spark in the center of the hole. The plane of the orbits of the planets sliced through the doughnut the way one would slice a bagel. The debris cloud got less and less dense the farther one got from that plane.

"Pity we can't orbit the arrays over

the poles," I offered.

Emma groaned. "Basic astrodynamics. Sorry, Bruce. Critiquing, aren't I. The project plan is for an equatorial ring. But even in a polar orbit, the arrays would still pass through the debris torus, and then there will be precession. . . ."

"Okay, okay," Dagger said. "But they only have to pass through the debris cloud twice an orbit, right? Most of the time the array is out in the clear. That's better than being in the mess all the time, isn't it?"

We all looked at him.

"Admiral?" Weaver said with renewed interest.

"The problem is one of rates," the *Admiral* responded. " Lowering the exposure lowers the rates, giving the robots a chance to catch up. We should be back into exponential growth in a few weeks. As far as visibility toward the impact station, we can tilt the array ring up to thirty-seven degrees inclination and still give the beam drivers a clear shot at the impactor."

"Well, this works for me," Weaver said.

"Don't we want to critique the rest of the ideas?" Emma said. "If it's a good process, the process should be served."

I thought about enduring a critique of my hostile intelligence idea. "'Tis not always necessary, if ye hit on something that looks good right away," I offered.

Davra grinned at me. She'd caught the excitement of a potential solution. I winked back, happy to be noticed by her and relieved that the team seemed to be reinvigorated and pulling together.

Emma didn't react; she had that faraway look of one communing with the computer over her neural net. "Very well. In these conditions, we should need at least 28.75 degrees inclination to cut the impact rate down enough for exponential growth. The reaction mass needed to push the array elements into the new orbit would be about as much as the mass of the array itself."

"Yeah, well, I've got an idea about that," Dagger said. "We can have array elements north and south of the orbital plane push on each other by tossing mass back and forth with rotating tethers. It's like a couple of sailboats with fans, each blowing the same wind back and forth at each other."

Emma frowned. "But half of the array segments would go into an orbit tilted one way and the other half would go in an orbit tilted in the opposite direction."

"So?" Dagger replied. "All we care about is that the orbits are out of the debris most of the time."

"Hmm," Weaver said. "This begins to sound like it might work. *Admiral?"*

The group dynamic was still working, I thought, but with some unvoiced concern. Weaver looked relieved. I was partly worried, and partly impressed, by how hands-off he was. There were lots of smiles and nods, but very little involvement in the discussion or even managing the discussion. There are techniques for leading problem-solving efforts, but he seemed to rely mainly on his personality and aura of command. Would that take us far enough? I wondered.

"Dr. Dickson's idea would significantly reduce the time to achieve exponential array growth," the AI said.

"Davra?" Weaver nodded her way.

"Coaxial electromagnetic launchers would make more sense than tethers," Davra said. "Simpler."

Dagger laughed. "Only if you're fixated on things going in and out. . . ."

"I fail to get your point," Emma said. "What does that . . . Oh, my!"

Davra gave her a lopsided ironical grin. "I don't think anyone's been getting Dagger's point lately."

Groans all around signified the end of the meeting. But they were groans with smiles.

Chapter 4
Asgard, Epsilon Eridani System,
25 March 2274

Two months passed. Schemes may unfold in one's mind in an instant and be communicated in a few minutes. But when such schemes involve the rearrangement of the heavens, some time is required. Meanwhile, we got ahead of the game enough to allocate some resources to finishing the habitat.

About two hundred fifty days after our arrival in the system, the habitat shell was finally completed, and we all piled into a runabout to watch the flipover and spinup. It lay before us like a huge silver egg, with one long end toward the star. Brilliant violet plumes erupted around the shell's shadow line/fusion rocket exhaust. The rockets began the spinup with their initial thrust vectors just enough canted that the shell slowly swung up as the applied forces and moments of inertia performed their complex, carefully calculated dance. After three hours of ponderous, majestic twisting, the fusion flames vanished and the habitat was left with its long axis at right angles to its orbital plane and spinning fast enough to provide one third of an Earth gravity. We were all suitably impressed.

Over the next few days, a thin film mirror, angled to reflect sunlight down into the habitat, was erected over its north pole on a "despin platform" that rotated in the opposite sense of the habitat, to keep it pointed at the star and to provide a landing place for the various runabouts and shuttles. Magnetic fields sprang up to protect the area from particle storms.

Finally, near the first anniversary of our arrival, Weaver gave the welcome command to defrost the rest of the crew and move everyone to the newly completed habitat. I moved my things into my new quarters, a cottage on a tributary to the equatorial lake surrounded by saplings.

But grass still grows more quickly than trees, and Dagger soon had a place for his second-favorite recreational activity: the game of golf. The course was laid out in a great circle a couple of kilometers north of the central river so that one almost always struck the ball in the direction of the habitat's rotation; this brought a drive down about as quickly as it would have come down on Earth, despite the lower centrifugal gravity of the habitat. Dagger was a fanatic, and I soon found that, embarrassing as it was for a Scot, I could not play at his level.

The habitat needed a name. In line with the Norse mythology theme of the rest of the system, it became Asgard. We all settled in. Trees, aided by modified genes and soil additives, grew rapidly. So did the culture, for which we had plenty of time. That culture, as one might suspect, had much in common with other remote outposts throughout the history of exploration.

With the habitat up and running, our original group had blended into the general populace. While I still took careful note of what was going on, a certain routine had set in. I'd taken up my previous profession, and begun a class on the history and philosophy of astronautics. This, of course, meant the joy of imparting knowledge was balanced by the drudgery of grading. So I welcomed Emma's call.

On screen.

There was a rather un-Emma-like twinkle in the astrophysicist's eye. "We're having a little reunion of the early birds at Dagger's place tonight. Can you come?"

"Aye, it would be good to see everyone."

"1000 hours, tomorrow. You'll not mention this to Dagger now?"

"You mean a surprise party?"

"Indeed. Cheers!"

If Dagger reacted true to form, I thought, it could be fun. Dagger enjoyed pulling practical jokes, so getting one back on him would be quite the ticket.

"We'll meet where his path turns off the West River."

"Aye, see you then."

* * *

Dagger's cottage of cast stone looked something like one might find in the middle of his native Maine. It even had a replicated stone wall along the front of the house with wild roses lovingly tended by microbots. We were kept outside for a couple of minutes—long enough to wonder who else might be there.

The front door, a large piece of solid replicated wood, opened and Dagger, looking half asleep, looked out at us. I saw that his right arm was covered in a cast.

"Surprise!" We all shouted.

He suddenly awoke, shook his head, and blinked his eyes.

"That'll teach me to run simulations past midnight. Well, come on in!"

We filed in and took seats around Dagger's grand stone fireplace, complete with simulated fire. It was cool enough in here that the warmth was welcome. We ordered drinks and his domestic robot brought them.

Dagger thrust the appliance on his arm toward me. "Will you look at this, Bruce?" Dagger's face was a mixture of mock disbelief and outrage. "I went to bed in perfect health and woke up with this! You're a historian of technology. Do you know what this is?"

I dutifully looked the appliance over. "It's a cast." They were made to immobilize the arm to allow it to heal from a break. But nowadays, of course, we'd simply have a robosurgeon glue the bones back together. But I gained my comm implant in a similar way, so I'm sure there must be some other medical explanation. Jill?"

The biologist shrugged, but the twinkle in her eye told me she was in on it.

"Oh, come on," Dagger implored. "Something's up, someone knows!"

"Ladies," Emma said, "I think we're being asked for a diagnosis."

"Better tell our Don Juan what this appliance is for," Jill said, "or he's likely to go crazy."

Davra grinned. *"Admiral?"*

"It had come to my attention that Dagger's hand was in danger of repetitive stress syndrome caused from his efforts to modify his golf swing to compensate for Coriolis force."

We could hold our laughter no more. Seeing which way this was going, I touched the net to ask the *Admiral* to send us some of my replicated Talisker.

Dagger looked at us with disgust. "So that's it now. I'm warning you, I'll be getting even."

"Dagger dear," Davra cooed, "you could just let it ride and call it even."

"Oh, no. Letting things ride, that's not me. The chase is on."

I looked at him in apprehension, then he broke out in a laugh. "Just kidding. Maybe. I think she wants you next, Bruce. If I were you, I'd look out."

The whisky arrived. "I'll be trying a bit of bribery instead," I said. "Shall we toast to the balancing of the books?" The robotic servant produced glasses of the amber liquid, and I passed them out.

G. P. Weaver arrived as I did so. He seemed unhappy, but not, perhaps, about our escapade.

"Sorry I'm late, folks. What's this about retribution?"

We told him and he shook his head. "Folks, this is a fifty-year mission." Then he raised his glass of whisky and joined the party.

Within our diverse community of scientists and engineers, there was a great sharing of cultural conditions. About six months after Dagger got his cast, I let him, Emma, and Davra talk me into a rendition or two on the bagpipes. I remembered that Emma had not done badly on the lute herself the previous month, while wearing an Elizabethan dress, even.

I had invited the gang over for libations, but my real purpose was to fill in some details on our debris problem. They were having fun sidetracking me, of course.

"So, having done my duty," Emma continued, "why don't you consider up-holding your end of the British Isles? Play the pipes for us."

I smiled. If you would know the truth, I am a wee bit more of a science historian than Scots culture historian, but I had played the pipes a time or two and could do serviceable renditions of "Auld Lang Syne" and "Scotland the Brave" along with a few lesser known tunes requiring a more cultivated ear. "Some," I replied.

"And you could come up with suitable national dress?" Dagger wanted to know. "You'd look nice in a dress."

I gave him a withering look. So, I thought, if I was going to do the bagpipes, I'd have to come up with a kilt. "I dinna bring one with me, but with the help of our replicator, I should be able to manage that as well. And, it is not a dress!"

"Okay, okay," Davra said. "Pipes and kilt at 1900 Thursday?"

"It shall be done." I was eager to get back to my job as an historian. "How are things going?" I asked her.

"Our doubling period is down to about forty-five days and pretty much holding there. The more robots we make, the higher the debris flux gets." She looked at Emma. "Tell him about your sims."

"My simulations show that the system had been moving toward resonance before the latest increase in magnetic activity. Things were settling into rings, Lagrange points, and so on. But the increase in flare activity, starting about six years ago, caused a lot of outgassing and nongravitational accelerations."

"Heat up an asteroid with a lot of ice in it, and it turns into a steam rocket," Davra commented.

"Thank you, I've read my Whipple," I told her with a smile. "They move into different orbits and run into things."

Emma nodded. "The debris population goes up by orders of magnitude. A lot of the stuff farther out gets perturbed into Loki's sphere of influence, and not a small amount of that stuff has been flung into the inner system in retrograde orbits. It's just now arriving at relative velocities of forty to sixty kilometers per second."

"Kersplat," Dagger said.

Emma smiled. "Also, we only use about ten percent of the mass we mine; the rest goes into orbiting slag piles, and they get hit, too, creating even more debris."

"Yeah," Dagger said. "We're doing something about that now. We've got all the mass from the next load in one slag pile, so the amount of exposed surface is way down. And we're gonna dump that right into Epsilon Eridani so we don't have to keep defending the array from impacts."

Davra nodded. "I've got enough robots on the job that some can be spared to seek out and consolidate potential impactors, even if we're not mining them. We'll dump them in the star, too."

Emma cleared her throat. "I can see the increase in metallicity in the star's atmosphere from what we've done already."

Something in the back of my mind started wondering if that was entirely a good thing. I put it out of my mind. A star is not conscious, I thought, and so could not resent garbage being dumped on it, could it? Well, I was still uneasy, so, without telling a soul, I resolved to do a little checking of the history of the system since we started interfering with it.

The *Admiral* and I fashioned a plaid and pleated skirt with a bit of mantle for my costume. I chose a traditional plaid from the Isle of Skye. In this I had the assistance of Kiri-Jean Stewart, a recently defrosted science anthropologist whose business was to study scientists as they studied the Universe. A big, cheerful, redheaded lass, she was actually from Christchurch, New Zealand, but she took her heritage seriously.

The bagpipe took a bit more work to assemble. Kiri-Jean said I fussed over the reeds for the pipe and drones a bit too much. Now I may have thought, Och, but does the lassie know! But I was very polite about everything as there was a bit of chemistry between us for our common interest.

Finally the day arrived.

The pseudo-lamb dinner had been served. Davra and Weaver passed around a selection of synthesized single malt whisky, and everyone settled back for my performance. I had Dagger sit just behind me for the last bit.

As luck would have it, Asgard had developed some of its own weather and greeted the evening with a dark cloud between us and the axis, from which a sprinkle of cold rain fell. Well, the plants had to drink, too, so we crowded into our small theater.

I played a rendition of "Scotland the Brave," the one everyone thinks of when you hear a bagpipe band in a parade. Everyone clapped. Aye, I thought, and they'll clap for "Highland Laddie" as well. The test would come later.

Still, after three of the lesser airs, the audience applauded and asked for more. So I played two more energetic tunes, then threw off my pipes in the general direction of Dagger to symbolize the music was of my soul and not from the pipes themselves.

I bowed to a wonderful round of applause and invited them all to "drink up!" I was feeling entirely too good and pleased with myself and had completely forgotten that the second shoe had not dropped, so to speak, from the escapade Dagger and I had in the unfinished habitat. Ironically, I was probably not ten meters from where that ill-fated conversation had been held, on the other side of Asgard's shell.

As I sat down, Weaver stopped by.

"A good rendition, Bruce. Thank you."

"My pleasure, sir!"

I could tell, though, that he had something more on his mind than the bagpipes.

No more had I reached down to pick up my drink when I discovered it gone. Looking up, I saw serving robots disappearing with all the glasses, many like mine still with a wee bit of whisky in them. I was about to register a protest when more bagpipe music wafted into the theater. It was a slow piece, "The Lament of Children," and it was played in the style of the old MacCrimmon family from Skye. I gripped the table to hold myself steady, remembering the legend, suddenly being transported back to Skye, to the pubs, to the college that was a dozen light-years from here. Tears welled up, I kept them back. Get a grip, man, I told myself.

Emma stepped through the companionway with a tray of small port glasses filled with a dark fluid. Something strange was going on here. The tunic she wore was the genuine mustard-colored linen with the bellowing sleeves and had no belt.

Of course. They'd wanted a Scot in a kilt and I'd not thought any further about it, nor had Kiri-Jean. So I'd ordered up what they were used to seeing.

But I had a sinking feeling this was much more authentic. Over the tunic, she had draped what was labeled a 'leine,' a mantle such as might have been worn by a twelfth-century warrior, held over her shoulder with a brooch that was no doubt an accurate relic of the time. Her beautiful legs were covered in the traditional garter socks; that much I recognized.

I felt chagrined. The Isle of Skye's honor had been duly served, but not by me. Emma set the tray down, picked up a glass, and gave it to me while taking one for herself.

"To Skye," she said, and the toast echoed through the hall.

The liquid poured down my throat and a smile spread across my lips. It was no whisky, but Bonny Prince Charlie's Drambuie, and it melted its way down my gullet and into my stomach.

I turned to Kiri-Jean. "Well, it appears

I've been upped."

Her eyes twinkled and she couldn't keep her face straight.

"Oh, no, lass, you're in on it?"

She laughed.

Well, it appeared that I indeed had been had, and I'd best be a good sport about it.

I thrashed the glass to the table, stood and swept up Emma in my arms, carried her to the stage, and set her down beside me. She took this all with characteristic aplomb, I should add.

"Well, now," I told the audience. "I stand here upstaged in my own culture by this charming young English woman. What you are drinking is a recipe of Drambuie given to my fellow Isle of Skye islanders by the Bonnie Prince Charlie as we rescued him from the redcoats. And, ladies and gentlemen, before you, on Emma, is a kilt from the twelfth century, Scotland, far older than the one that I wear."

She laughed and spun around so they could see the whole thing.

"What Dr. Macready is wearing," she said, "was a version created in the seventeenth century so Scots workmen would safely work in a forge. It was, in fact, designed by an Englishman."

I looked down, mouth open. "Ye dinna say," I said weakly.

The *Admiral* confirmed it, as laughter cascaded through the audience.

Someone who sounded a lot like Dagger yelled from the back, "Time to kiss and make up." So I took Emma's hand and did so.

"Even?" I asked.

"Perhaps," she said with a smile, turned, and headed off the stage.

Well, the rest of the party went on very well. Kiri-Jean, another couple who were actually from Glasgow, and I helped get everyone dancing some simple jigs—inhibitions and muscles being well lubricated with the ersatz whisky and Drambuie. Weaver, of all people, actually managed it quite well.

After cleanup, we early birds plus Kiri-Jean went off to Weaver's ranch. He had a half dozen colts and fillies on some clear land about four kilometers from the central lake.

"I know how it was done," I said, "but I'm still amazed at how big a horse can get only six months from an artificial womb and bottle feeding."

Weaver smiled with the pride of a parent. "I started saddle training a couple weeks ago. No riding yet, but just to get them used to something on their backs."

"They are beautiful," Kiri-Jean said. "My family has horses back in New Zealand."

Everyone went to the corral fence to be near the horses except Emma, who held back, apparently lost in thought. But even she was soon petting the colt with a white star on its forehead, who seemed to want all the attention for himself, snorting at any of his siblings that dared come close to us three humans.

It was too good a moment to end, but it did. I heard rapid footsteps come up behind us. It was Emma.

"Everyone, we have a problem. A major planetesimal headed for the array."

Emma had the *Admiral* circle one of a thousand comets displayed in the dome. Its statistics appeared beside it. "That one," she said, "is the threat."

It didn't look any more threatening to me than all the others. Hardly any tail at all.

"Oh, crap!" Davra said.

Emma raised an eyebrow. "Indeed. Here's the projection." A graphic of the system appeared on the dome, replacing a big square of star field. The array was visible as a tiny train of thin blue squares gliding slowly around the star about a thumb's width away from it, from my perspective. The comet was shown as a blinking white dot, an arm's length away, trailing fainter dots as it rushed along its path.

"It's on an orbit tangent to the array orbit, same inclination, same periapsis. In eight months, it will plow into the trailing half of the array right here."

A broken red line appeared in front of the comet and joined the array before heading back out to our Kuiper belt. My eyes flipped back to first image, and looked at the numbers again. It looked like all the rest because it was farther away.

Weaver looked concerned. "How are we going to divert that? It's as big as Pluto."

"We have a Norse naming convention in this system," Emma said. "I've called it Skrymir. He was an ice giant."

"What I want to know is where did it come from?" Dagger asked. "Why is it a surprise?" He frowned and ran his hand through his hair.

Emma looked uncomfortable. "It was not on that orbit a week ago. It got hit by another smaller comet, one of thousands whose orbit had changed due to increased outgassing, due to the current anomalously high stellar activity. It passes near the giant planet Loki in three weeks, and Loki's gravity greatly magnifies the small change produced by the comet impact. The odds against this happening precisely this way were, well, astronomically high."

"If it's too big to move, maybe we can move the array," Davra said. *"Admiral?"*

"This would put us behind schedule again, but not impossibly so."

"Hey," Dagger said. "If a comet strike put it in this orbit, could another take it out?"

"Yes," the *Admiral* answered, "assuming Skrymir stays on its present course." The Admiral circled a tiny dot on the dome. "This new comet will pass within about a billion kilometers of Skrymir, in three months. A velocity change of about 1.2 meters per second on this newer comet would cause it to strike Skrymir essentially head on. The comet should hit with enough energy to cause Skrymir to miss the trailing end of the array. Probably enough to make it hit the star itself so it won't be a problem on the other side of its orbit. Like this." Dotted lines on the diagram changed to show Skrymir being hit and falling into Epsilon Eridani.

"That appears to take care of the problem for now," Weaver said, nodding. "Make it so."

It so happened that Skrymir would strike Epsilon Eridani near the upper left of the star's disk as seen from Asgard; a potentially spectacular sight. But a problem with living on the inside of a rotating habitat is that the lights in the sky at night are not stars, but the lights in the other houses above you. To see what's going on with one's own eyes, one must go outside.

Thus, the entire population of our tiny colony gathered in spacesuits on the sunward edge of the north pole despun platform. Our robots had temporarily repositioned the colony's main light-collecting mirror between us and Epsilon Eridani, creating the effect of a total eclipse.

The corona of the star was awesome, streamers going out several times the diameter of the disk. The array, a line of collectors nearly forty million kilometers long at this point, was foreshortened to a brilliant dot from our point of view. It looked somewhat like an elongated version of the planet Venus as seen from Earth. One could still see the gas from Skrymir streaming away from the star and toward the array.

"They've collided," Emma announced. "We should see the effects as the light reaches us—in about six minutes. Watch the tail of Skrymir."

It seemed like a long wait. Then, an incredible brilliant white wave began to race up the comet's tail away from the star. A collective "Oh!" came from our helmet speakers.

"It isn't often one gets the chance to actually see the speed of light," Emma commented, her voice filled with awe.

Meanwhile, a brilliant dome began to peek above the edge of our artificial moon, casting sharp shadows surrounded initially by light that was nearly blue white. Its growth was like watching the Sun rise over a distant hill on a clear day back on Skye.

"Did that do anything to the star?" someone asked.

"Not that we know of," Emma replied. "What you see is an extremely thin plasma of star and planetesimal material that fluoresces and glows in the starlight. The amount of mass and energy involved are insignificant by stellar standards."

I was watching the band around my shadow change colors when I saw a second, fainter shadow appear. I looked back to the sky.

The array, bathed in the light of the impact, had become noticeably more brilliant, maybe two or three magnitudes brighter than Venus from Earth, I estimated.

Gradually, things began to fade and people, with other things to do, began getting back to the locks and vanished into the habitat. I lingered a while, with Davra, as the impact dome dissipated and its light faded to deep orange.

"We'll be moving the mirror back in a few minutes. Wouldn't do to get the habitat cold."

"Aye. Davra, I have a sense of déjà-vu about this." I would remember it in detail, of course, as soon as I recognized what it was that I was trying to remember.

Chapter 5
Asgard, Epsilon Eridani System, 5 April 2274

Next month, epsilon Eridani's magnetic weather went crazy again, and gave birth to a super flare. We called it "the Inconstant Moon flare," after the Larry Niven story about the moon suddenly getting bright enough to make people think the Sun had somehow become a nova. We didn't have a moon, but the flare lit up the system's giant planet, Loki, so much that one could see by the reflected flare light. Indeed, we actually turned Asgard's mirror away from Epsilon Eridani and used Loki's light for a couple of days. It wasn't enough to provide heat or normal levels of photosynthesis, but it was easily enough to read by, and our star was putting out a wee bit too much light.

Wonders aside, the array was in ruins and we were all in a black mood. The damage was so extensive, and so many robots had been damaged to so many varying degrees that it would be a week or two before we had a good handle on just how bad it was.

When we did, Weaver called a meeting. The project management meeting center on Asgard was a large circle under a video dome. A round table sat in the middle, causing local wags to call the building "Camelot." Depending on whom you asked, the table either had no head, or the head was wherever Weaver decided to sit. He waited until everyone else sat down before he entered. There were ten of us now, with two additional experts sharing in planetary astrophysics, robotics, and project engineering, working with Emma, Davra, and Dagger.

There was a long silence. Finally, Dagger spoke up. "We have twenty months or so before we have to launch the impactor. There's no shortage of raw material anywhere in this system. If we didn't have to deal with debris attrition, how fast could we rebuild it, *Admiral?*"

"Assuming enough material, without degradation, 728 days," the AI said.

"We are supposed to launch the impactor in 640 days," one of the new experts said.

"We all know that," Weaver said, sounding very dejected. Normally of erect posture, he sat slouched in his chair, frowning.

There was a great silence then; the cacophony of a room full of furious thinking. Could it be that it was all over? I knew the political situation on Earth; it would be a long time indeed before another attempt could be made. Perhaps with four different stars? Or would it be made at all? Would humanity turn inside, as China had a thousand years earlier, content with limits that did not risk upsetting the basis of rule?

Finally, Weaver turned to me, of all people. "Bruce, you're good at teasing ideas out of people. Think you can pull a miracle out of your brainstorming hat?"

I frowned; an observer such as myself shouldn't be taking a main role in events—it raises issues of objectivity in the end. Nonetheless, my help was being asked. It was just another departmental meeting, I told myself, though with higher stakes.

"I canna guarantee any results, but I'd be happy to give it a try. But first I think we might review some of the roads not taken in the last session."

Dagger suggested building the array farther out, using reflectors.

"Could we not do that, then angle the reflectors away if a big flare comes?"

Emma shook her head. "There's not enough time to move the array to an orbit far enough out. The modules would need to coast for a year. Then we'd need to figure out a way to push them in to circularize . . ."

"Why?" Dagger asked. "Why bother to circularize?"

Weaver looked at him sharply, then his features relaxed. "Doesn't make much difference, I suppose. No good to anyone after we're gone."

Emma frowned. "Even if we just let them go . . . But maybe, if we really don't care . . ."

We all looked at her.

"There is a high inclination planetesimal inbound that we could use for raw materials," she said, "or maybe an escaped moon. Loki throws one up there occasionally. Call it Skrymir II. It will eventually get within a couple hundredths of an astronomical unit of Epsilon Eridani and likely be vaporized. But not until about four years from now."

"We have lots of robots now," Davra said. "We can get them out there quickly with the surviving array modules. Without any interference, our doubling period could get down to maybe twenty days." She held up a hand while she consulted the net. "Still not enough."

"Yeah, well, it would be enough to *start* the impactor," Dagger said. "Maybe we'll think of something else in the meantime."

"Yes, and maybe pigs will fly," Weaver said.

We went around this way for another three hours without coming up with anything better. With the *Admiral*'s help and another brainstorming session, we somehow managed to convince ourselves that if we could get started, maybe something would come up.

Soon everything was again in the hands of the automated systems. At best, it would be the better part of a quarter century before an attempt was made again. And at some point, we would have to admit failure and warn the project that our impactor would be late. But everyone was still trying to come up with a scheme to save the situation.

Three weeks after the "Inconstant Moon" flare, Weaver left a message for me: "New colt's a beaut. Come over Tuesday evening after my exercise, and we'll trade horse stories."

Weaver's third colt—a young filly—had lately put a little sparkle in his eye again. Meanwhile, Star had grown big enough to ride, and Weaver liked to go out among the sculpted crags and streams of the south end of Asgard, where the artificial land curved up toward its spin axis.

Trading horse stories was Weaver-speak for getting us updated on the colts and getting him updated on what we were all doing. Tuesday, I took myself off the net to enjoy a walk and arrived shortly before our "sun" set behind the north end hills.

"Hi, Bruce." It was Dagger, leaning up against the rail and petting the jet-black new arrival.

"Weaver still out?"

He nodded. I had a flask of ersatz Talisker with me, which I passed to him.

"Asked Davra out yet?" he asked, after a swig.

I laughed and shook my head. "I don't know. I don't think she's my type. . . ."

Laughter as clear as a bell rang out. "Don't you guys ever learn anything?"

Davra sauntered into view wearing a cowboy hat, jeans and a bright blue halter with two big red stars on the only place big enough for big red stars.

"I'll decide who's my type. . . ." Davra held up a hand as if listening on her neural net. Her smile vanished and her face turned into one of shock.

I put myself back on the net and instantly got an urgent incoming. I could see Dagger had one too.

It was Jill. *Not good news, everyone. I'm at the clinic. G. P. is dead.*

Dead! I sent, *How can anyone be dead anymore?*

They think it was a riding accident. He was off the net. When he didn't show up for our date, I sent an emergency message. He didn't respond. I called public safety, and they found him with the survey cameras up in the rocks up by the north pole with his head bashed in and the colt nuzzling him. They had him in the clinic in ten minutes, but it was too late.

"I've got a car coming," Dagger said. "Five minutes."

How are you doing? I asked Jill.

There was a pause. *I feel awful. The horses aren't used to the low gravity up there. The trails aren't maintained as much. It's the sort of thing G. P. does to clear his mind when the burdens become overwhelming and he isn't careful. I should have said something to him. If I'd only called earlier . . .*

Jill, don't blame yourself, I sent.

"Damn!" Davra said. "He was awfully down. You don't think he arranged . . ."

Dagger shook his head. "Not Weaver! He'd think that was a coward's way out."

"Aye," I said. "But people with problems who would never think of killing themselves still might give death more of an opportunity to solve their problems than it would normally have. In the First World War, Churchill, fired from the Admiralty because of the Gallipoli disaster, went into the army and exposed himself to fire on the western front. He survived. Tchaikovsky, failing in personal relationships with women and men, drank tainted water. He died. An American President, Nixon, about to be forced from office, went on a strenuous foreign mission with blood clots in his leg. No such luck, mind you, he lived to be disgraced."

People stared at me.

"On the other hand, maybe it was just an accident," I said, but I wondered.

Then the fan car arrived and set down in a swirl of leaves. Everyone piled in.

Whether by intention or premonition, Weaver had left final instructions only a few days old. He wished his remains to fertilize the soil of the uplands he loved, so we buried him on a rise of ground with a fine view of Asgard spread out below. Jill planted flowers from the same pot I'd seen in his quarters over the years. I played "Amazing Grace" on the pipes.

"We need a leader," Dagger announced as we stared at each other across the circular table.

One chair had been left empty, not by any design; it had just happened that way, and no one had come to fill it. Dagger had become acting director on Weaver's death, but made it clear that was temporary.

"There seems to be a consensus among the project people that it be one of us early birds," he continued. "In fairness, whoever it's going to be will probably have to tell the universe we failed."

"Isn't that a wee bit premature?" I asked. "We haven't tackled this one yet. Every time we do, we come up with something."

"Someone has to preside," Davra said.

"It just isn't my thing," Dagger answered. "I do better kibitzing. Anyone here have any management experience? Emma, you led the astronomy team."

She shook her head. "And my reputation hasn't suffered enough, has it?"

I thought to object, but held my tongue. She had a point.

"Davra?" Dagger asked.

She looked around the table at a number of frowns, then shook her head, too. "I have enough to worry about with the robotics. And besides," she lowered her voice, "it might interfere with my social life."

Though the remark was clearly meant for the laughs it got, she had a point also.

Jill stood up. "What we need is a generalist, someone who has an overall view of everything. The department heads already have their hands full. Bruce Macready is such a person."

My jaw dropped. I looked at Dagger, who raised an eyebrow; at Emma, who seemed to be looking somewhere else; then at Davra, who smiled as if she'd just swallowed the canary.

Jill continued. "He has personally chronicled every event from the time we left Earth. He has interviewed everyone here, and he has a good working knowledge of our overall mission. At Broadford College, he chaired his department twenty-three times and served as chancellor for a decade. He's also been three times president of the International Science Historians Guild."

"Now wait a minute," I objected. "Yes, I've had a wee bit of what you might call management experience, but none of it at this level of responsibility."

They looked at me again. How had this happened? I asked myself. I'd come along to report on this thing, not to run it. Bruce, I told myself, they do not want a leader as much as a scapegoat. But I met Davra's eyes, and those eyes seemed to say yes, in several ways. Are you going to go for it, Macready? For once in your life, are you going to go for it?

Of course, maybe if I had fully appreciated the impossibility of completing the mission with success at that time, I would have shied away too. So I don't know. But either for Davra's eyes or out of ignorance and hope for something of significance to show for my time out at Epsilon Eridani, I decided to pick up this caber and try to stick it upright.

"Very well, I'll ride point for you—but not to be throwing in the towel just yet. We have almost a year, do we not, before we run out of power to push the impactor on its designated profile?"

The *Admiral* confirmed this.

"Then we shall meet again tomorrow with our thinking caps on, aye?"

They all nodded.

"Weel, I'm feeling a bit dry just now. Those who want, come over to my house and we'll lift a glass to the late Dr. Weaver."

The wake was all that it should have been. Everyone brought a bottle of his or her favorite replicated liquor or drink and shared it around. One of Davra's people wailed away on an Irish fiddle while his wife dragged all the men to the center and taught them how to do an Irish jig. By and by, we were all dancing and singing and having what Dagger called a whale of a wake.

Very late into the evening, Davra jigged into my arms. We danced until I needed a wee breath, and so I took her hand and led her out to the edge of my garden. She looked me straight in the eye.

"Something on your mind, lass?"

She laughed softly. "I've got to come up with some entirely new strategy for getting the project back on target tomorrow and you ask if I've got something on my mind? Well, besides that what I've got on my mind right now is I'm horny as hell."

Call it a death wish, but there is something about me that will not even walk through an open door to my dreams. "I dinna know if I have a cure for that, lass."

She laughed again, took my hand and led me away from the house and the commotion of the party.

About halfway on the path, surrounded by trees and singing birds, she stopped. "Bruce, Bruce. Look at me. The real me."

I stared into her eyes. "You're a beautiful lass, a lot more than I could . . ."

"Oh, stop putting me on an unreachable pedestal. I'm a real woman who loves to love and I've always wanted to love you as much as anyone. Leave me on the ground where I belong."

"The ground is it?" I looked around; there was a small grassy clearing just a few feet from the path.

"Yes, oh yes!"

Summoning up nerve from I dinna know where, I took her hand. Her eyes glowed as she followed me through the brush, laughing. In the clearing, she kicked her sandals off and with one smooth motion, she pulled her long black dress over her head and stood before me naked.

She was beautiful, no doubt about it. This was a Davra I'd never seen before. Quiet, but excited, watching me, as I was her. Was she as nervous on the inside as I was, I wondered. I stepped to her and she grabbed my tunic and pulled it over my head, pressing her firm breasts against me as she did. The tunic fell to the ground, as in a moment did we. There, in the cool grass and soft leaves, we made love.

The next day was all business. I have a degree of stubbornness in me, and an analyst's bent. Up until now I'd put all my work into historical studies of what people did and why. Now it was a star I was trying to figure out, a star that seemed to consciously fight our every effort.

Well, what was this star's pattern, this opponent of mine? I looked up the history of the entire project from the first robotic presence to the present day, and made graphs of its activity and ours. A correlation was no great surprise, but indeed . . . A chill went down my spine.

I called Emma. "If ye look at this, it seems that when we throw something big at the star, it throws something back a few days later."

Her image on my wall screen shrugged. "It's always throwing stuff out. So it's always throwing stuff out when we throw stuff at it."

"But it happens when other stuff hits it, too. Natural stuff. If ye look at the correlation."

She frowned. "You're saying it's not random?"

"So does the *Admiral,* Emma."

There was a long silence. Finally, she said. "Bruce, you might get a paper out of this when we get back. Astronomy is probably friendlier to contributions by amateurs than most sciences."

She was trying to let me down gently, but I was not to be deterred. "But don't you see it, Emma? It's us that have been making the star flare. Us! By dumping our waste on it."

She paused for a bit, then shook her head. "Possibly. But how? The material doesn't penetrate, really; it just sort of splatters on the photosphere."

"But it's all kinds of metal, heavy ions, current paths . . ."

She gave me a wan smile. "Well, maybe. I'll suggest to Davra that she direct the waste elsewhere. I don't suppose it could hurt. Not that anything's going to help now."

Were there tears in her eyes?

"I dinna want to make you feel bad, Emma."

The look she gave me was unreadable. "No, I don't suppose you did."

There were long faces at Camelot. We

all had a bit of a toast as our impactor, that billion-ton iron caber, started its journey to the implosion vertex. But we had to acknowledge a larger sobering thought. We would ultimately call it quits if we didn't find more power in another hundred and thirty days.

"Almost twenty percent more," Dagger said, "We could actually use one of those big flares now."

"Huh?" we all said simultaneously.

"Sure," he said. "Photovoltaics like light. It's particle radiation that hurts them, but that's all down in the magnetosphere. They'll take as much as double the illumination."

"So why don't we just build bigger concentrating reflectors?" I asked.

"That's how we're keeping up," Davra said. "Can't build 'em any faster. We've got the surface of Skrymir II covered with robots, and it's getting noticeably smaller as we take stuff away. That's a bottleneck. To get more light, you'll need to make Epsilon Eridani brighter."

My eyes met Emma's. Come on, Lassie, I thought. You say it. Make it your idea and get back some of your self-respect.

"There may . . . may be a way of doing that," Emma said. "If we could dump a lot of mass in at the right time, it seems that flares should follow in a few days. Metallic ions affect currents beneath the photosphere, destabilizing it . . ."

"We've got plenty of slag to push," Davra said.

Emma nodded, then shut her eyes. She'd be in a silent, furious conversation with the *Admiral,* I thought.

Finally, she said, "It will take about a hundred and thirty two billion tons, if my model is right. Spread over several days with impacts maybe three hours apart."

"Well," Dagger added, "there's that much and more floating around this place. Let's get going." Then he looked at me with a curious expression on his face, as if he just remembered who was in charge.

I smiled and nodded. "Aye, let's do it."

As we left Camelot, Davra grabbed my hand. And Dagger took Emma's.

Weeks later, with the pellets all safely on their way to the accelerating impactor, I walked out with Davra to the rise where we buried G. P. Weaver. He and I had been confidants of sorts over the years, and it seemed right to give his headstone an update, if nothing else but to clarify some of those details every once in a while.

I also needed to prepare a message to the Vertex facility concerning what we'd done. They'd get it a few weeks before the impactors all arrived. I sat on a rock and brought up my notes. Davra sat beside me, looking out over this vast inside-out green, white, and blue Easter egg we lived in. In spite of everything, people were going to found an Epsilon Eridani colony. Davra and I had other plans, though. We were going with Captain Lee to Vertex to see how this all turned out, and then on to the Solar System and Skye—my whisky cache was about gone.

"You've sent the report?" Davra asked. "Emma's calculations were a bit conservative; a thousand massive bodies impacting the photosphere will . . ."

"Aye, I know. We need to let the Vertex facility know that, in spite of what they see, our impactor will arrive on time and with the right velocity. As for the rest of the galaxy, well, we can have a few days of fun with them." Galaxy was a wee exaggeration—only about a hundred settled star systems were involved.

Davra took my hand. "Oh, yes. I wonder what they'll think on Earth when, all of a sudden, Epsilon Eridani becomes one of the brightest stars in the sky." ■

(EDITOR'S NOTE: Earlier stories of the Black Hole Project were "Kremer's Limit" [July/August 2006], "Imperfect Gods" [December 2006], and "The Small Pond" [March 2007].)

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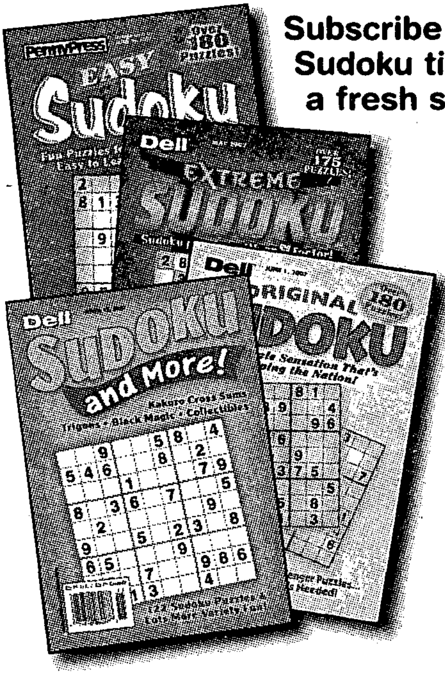
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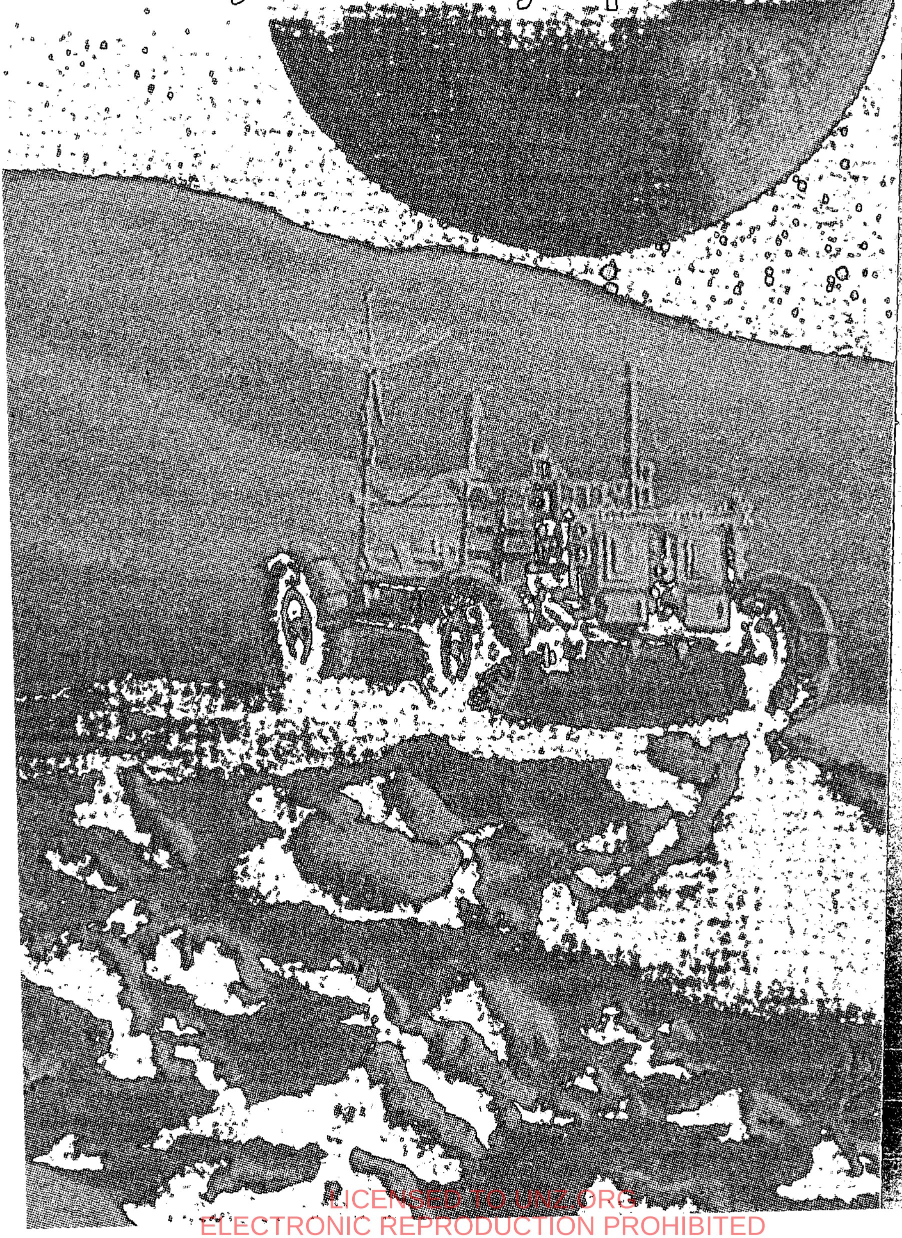
Bringing It All Back Home

Bud Webster

Illustrated by William Warren

Any job needs the right people to do it; and conventional qualifications are not necessarily the best way to pick them.



"So what's the verdict, Bubba?" The voice, although not unquestionably electronic, had a distinctly nonhuman timbre. It emanated from a small, flat box, rather like an Etch A Sketch, propped up against a particularly ugly lamp made from a small stuffed alligator. "Are we going to be on television?"

"Don't look like it, Mike." Sixtyish but still burly rather than fat, Bubba Pritchert brushed his hand through his short, salt-and-pepper hair and sighed as he looked at the letter in front of him. "Jamie and Adam went to bat for us, but that wasn't enough to make the cable suits change their minds." He shrugged. "Oh, well, we'd have had to relocate to California, and I been there once. Didn't care for it. I don't suppose it's changed all that much in the past forty-five years or so."

"I'd have thought that an experienced jackleg mechanic, an artificial intelligence, and an abnormally strong alien would have been a powerful asset to the Mythbusters, Bubba."

"Me too," he shrugged, "but I think it was that 'alien' thing that got to them." Bubba shook his head. "Damn. Hoss is gonna be real disappointed. He *loves* that show." Hoss, the alien in question, was a Thunt, a humanoid alien with more in common with a Shar-Pei than a terrestrial from the neck up; Bubba had befriended him several years before and had been adopted into his clan.[1] He laced his hands behind his head and stared at the ceiling. "I was looking forward to building a faster-than-light drive at M-5, too."

"Dream on, future-boy. It would be easier to build a time machine from stone knives and bearskins."

"There you go with that pop-culture stuff again. Don't you have anything better to do than watch reruns on TV?"

"Until we come up with a way to make me a lot more mobile than I am now, it's about all I *can* do," the Nishian artificial intelligence said.

now, your choices are to be a hovercraf or a helicopter. Or with skinny little legs and arms like that lightbulb guy from th Gyro Gearloose comics," Bubba sai thoughtfully. "Any way you look at it you'd be kickin' up dust." He shook hi head. "I was hopin', what with Jamie' experience buildin' robots, that I coul talk him into helpin' out. Ain't gonna ha pen now, looks like."

"I told you that you should have men tioned the work you did for NASA i 1973. . . ."

"Now, Mike," Bubba interrupted, didn't do all that much, just made a co ple of suggestions about how to put square peg in a round hole with a few j dicious whacks of a big hammer, is all.'

"Perhaps, but they called *you*, did they?"

"They didn't, Mahlon did. Saucer N Number Six-Sixty-Six, he was, our fi rocket scientist—though he hated be called that. He was working at JPL wh all that happened, and he figured I mi have some ideas about how to fudge CO$_2$ filters." He scratched the back of head. "Might've helped a little, I s'pc but they did all the hard work. They w the heroes." He frowned. "I really n Mahlon, he was cool as a moose an most as fuzzy."

The phone rang. Bubba's eyebr shot up in surprise. "Hmph! Maybe Discovery Channel changed t minds." He picked up the handset answered. "Yellow? The Prit-CHARD dence, mechanic of the house speaki

"Bubba, you've *got* to stop watc those Britcoms. They're having an u tunate effect on you." The voice o other end of the phone was brisk not brusque.

"Hey, Kirby! What's shakin', hom

"I believe the correct answer to t 'nothing but the leaves on the trees,' lawyer replied, "so let's take it as sai

"Stipulated, counselor," Bubba

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[1] See "The Three Labors of Bubba" in the June 1996 *Analog*.

"Whassup?"

"I've been contacted by one of the media people at the Smithsonian. Apparently," Kirby said wryly, "word of your, er, exotic personal conveyance has spread."

"And. . . ?"

"National Air and Space wants to hire you for a very special job."

"Oh, *do* they?" Bubba drawled. "Tell me more."

"I'm sending you e-mail about it even as we speak."

"And I'm downloading it now," Mike said.

"The wonders of a DSL connection. It's a little complicated, Bubba, but I don't think it's anything you can't handle. And in point of fact, I doubt there's anyone else who *can* handle it."

"I'll look it over," Bubba said. "Meanwhile, when you gonna come back down for the Urbanna Oyster Fest? You've missed it the past few years."

"If I can get out from under these congressional hearings, I'll be there this year. I'm certainly not going to let *you* get them all. I'll let you know when I know." They said their good-byes and rang off.

Bubba sat back in his overstuffed chair and picked thoughtfully at the frayed piping around the arm. It was late afternoon in Central Garage, and the early fall sun came through the living room window, tickling the array of toys on the shelves that lined the walls. Magazines and newspapers covered every flat surface in the room, and the hallways leading into the other rooms were lined with floor-to-ceiling bookshelves. In a rack by the television were dozens of DVDs ranging from classic screwball comedies to last year's monster fantasy epic.

"Got it, Bubba," Mike said, "along with three hundred other messages. How many mailing lists are you on, anyway?"

"Oh, one or two, I guess. It's all research."

"'SpaceGhostFan' is research?"

Bubba looked hurt. "Hey, it's a great show, Mike. Don't it remind you of home?"

The little box snorted static. "As if. Anyway, here it is."

Bubba read the words scrolling across the screen. "Well, don't that beat all," he said in wonder. "What do you think, Mike?"

"Well, it's certainly within your range of skills, and it won't take us nearly as long to make the round trip as they would."

"Any foreseeable snags?"

"Oh, only a hundred or so. Clearances, licenses, permits, fees . . . not to mention the fact that you've never flown to the Moon—at least, not that I know of."

"Nope, not yet, anyway. Think I'll have to get shots?"

"Frankly, Bubba, I don't know what kind of restrictions the government is going to put in your way. Shots are probably the least of your worries."

"Easy for *you* to say," he muttered. "It ain't your butt." He stared at the ceiling and a slow smile spread over his face. "Bringing the first Lunar Rover back from the Moon. The ultimate tow job." He laughed aloud. "Well, dip me in dog shit."

"You have to do it, Bubba," Mike said. "You know you have to."

Bubba nodded. "Oh, I'm gonna take the gig, all right. Just remains to be seen how the contract gets writ. Don't wanna soak 'em, but we're talkin' about some pretty serious mileage here." He rubbed his hands together. "Might even be able to get some 'considerations.' It'd be *so cool* to have a Moon rock, or one of the flags, or something like that. But," he sat up straight and picked up a pencil, "Mom taught me it don't pay to get too greedy."

"I'm sure they'll be as generous as they can be. And take it from me, a rock is a rock."

Bubba shook his head slowly. "No. Not to me, Mike. See, this stuff is no big deal to you. You been there, done that, and got the T-shirt—assuming you could wear it. To me, it's solid gold, a gem of purest ray serene."

"Now who's making obscure refer-

ences?"

Bubba peered at the little screen over his reading glasses. "You'd prefer I quote from Astroboy?"

"Astroboy; Aristotle, Alfred E. Neuman; it's all the same to me. It's not my culture."

"That mean you gonna give up watching TV?"

"Right after sweeps."

Bubba laughed. "As Eleanor of Aquitaine said, 'There'll be pork in the treetops come morning.'"

The contract arrived by courier the next day. It was thick, almost one hundred pages. "Son of a *bitch,*" Bubba said in wonder. "Hell, even Kirby'd choke on this thing. Wonder what's so god-awful involved in this that we can't just say, 'We the undersigned do hereby agree'?"

"You know better than that. This is a government contract. Everything has to be tied down in triplicate."

"I guess so, Mike, but all this," he waved the sheaf of papers, "just seems so unnecessary. I ain't gonna steal it from 'em and sell it to a chop shop. All I want is to be able to say I did it and get a little promotional use from it, and they already agreed to that." He tossed it on the table. "I dunno, Mike. Maybe things were different when you were with the Nishian Parliament . . ."[2]

"They weren't."

". . . but all this hoop-de-doo about a simple tow job is, well, it's draconian, is what it is."

"Er, Bubba, that statement doesn't make sense."

He shrugged. "Yeah, I know, but I always wanted to use 'draconian' in a sentence." He rustled the pages in frustration. "Shit on a stick. I ain't gonna 'grand theft' nothing, I just want the gig. Anyway, who could want anything more than to go to the Moon, for the love of Pete?"

"I'll look it over," Mike said. "I'm not admitted to the bar here, but I've got access to every online legal database. If there's something wonky, I'll run it past Kirby. Between the two of us, I think we can catch any problems."

"I trust you. Check and see if there's anything in there that says I can't grab a moon rock or two for myself, will you?"

"Just a second . . . no. The only proscription is against profiting directly from anything you retrieve."

"In other words, I can bring it back, but I can't sell it on eBay."

"Correct. You can, however, use any unclassified aspects of this project as promotional material."

Bubba nodded thoughtfully. "And then there's the lecture and talk show circuit, county fairs . . . Might even be a book in it, you never know."

"Bubba, you've never written a word in your life."

"Well, there's that guy up in Richmond. I understand he'll write damn near anything for a buck."

"That hack? He writes sci fi. You want a *real* writer."

"Mikey, old top, that *is* real writin'."

Artificial intelligences, even those created by alien cultures and subsequently acquired by retired Virginia auto mechanics, cannot sigh. They have no lungs, no need to breathe, no diaphragm with which to push air past relaxed vocal cords, assuming they had vocal cords, which they don't.

Mike sighed. "Whatever you say, boss. Whatever you say."

The scout ship made almost no sound as it swooped through the open front doors of the garage, past the empty bays, and back out the rear doors. And again, and again. And again. Each time, it cleared the ground and structure by mere inches. A small crowd had gathered to watch, ooh-ing and ah-ing as Bubba Pritchert practiced flying in preparation for his trip to the Moon.

After making numerous loops into the

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[2] See "Bubba Pritchert and the Space Aliens" in the July/August 1994 *Analog*.

garage and back out, a King William County patrol car drove up and a tall, thin, uniformed man got out, stretched, and settled his hat on his balding head. Reaching back down into the car, he brought out a microphone and thumbed it.

"Edgar Allan Poe Hudgins Pritchert." His voice crackled through the loudspeaker on the roof of the car. "This is Deputy Sheriff Lester Beason. Please ground your vehicle. We need to speak to you." He waited, but the saucer only looped through the garage again. A smaller man in a tailored suit slid out of the patrol car on the passenger side and brushed at his suit jacket.

"Well, officer?" he said in clipped tones. "Is he coming down?"

The deputy sighed. "I'm trying, sir, but I'd like to remind you that he *is* in a flying saucer."

"I'm well aware of that, Deputy. That's why I'm here." He straightened his lapels. "Can you try a little harder, please?"

The tall man sighed again. "Yes, sir." He thumbed the microphone again and spoke in a louder voice. "Mr. Pritchert, I'm afraid I have to order you to land your aircraft, or whatever the hell it is. There's a man from the government here to talk to you."

Still the saucer flew overhead, zigzagging and rolling to the evident delight of the crowd.

The government man sighed. "Really, Deputy. Isn't there *something*. . . ?"

"What do you want me to do, Mr. Breen?" Beason snapped. "Shoot him down? Damn it, Bubba!" he shouted into the mic. "Will you put that thing in the garage and shut it down?"

The saucer came to a dead halt just overhead, and there was a click as a hidden speaker was activated. "I've had it in the garage a dozen times or more, Lester," came Bubba's voice. "Why ain't you locked the doors?" With that the saucer swooped into the garage and stopped dead in the air just inside; it spun lazily and settled gently to the floor. It was bigger than it had looked outdoors, almost filling the double-width doorway and standing a good ten feet high. With a low hiss a panel in the side slid up, and a short ramp extended to the floor. Bubba stepped out of the craft and the ramp and panel closed behind him.

"Yo, Deppity. How's Big Lester?"

Beason cleared his throat uneasily. "Dad's fine, Bubba. Sends his best, but he says he'd appreciate it if you wouldn't fly that thing over his deer stand. You're scaring the game."

Bubba shrugged. "Oughtn't to be jacklighting 'em, then. They gotta have *some* chance, don't they?"

"Has he been doing that again?" Beason was clearly angry. "Goddamit, I told him . . ."

"Deputy Beason," the young man interrupted sharply. "Can we please get down to business? I've come a long way, and this is important."

"Yeah, okay. Bubba, this here is Mr. Martin Breen from the FAA. He needs to talk to you about your . . . about that thing you've been flying around in."

Bubba extended his hand. "Mr. Breen, nice to meet you."

Breen took his hand gingerly and shook it exactly twice. His hand was cool and dry. "Yes. Well. Mr. Pritchert, I am a field investigator for the FAA. You've been operating an unidentified flying object."

"Naw, it ain't. I can identify it. See?" He pointed to a plate riveted to the side of the saucer that read, "The USS Right Honorable Fireball XL-5. She's got her own nameplate and everything." Breen just stared at him. "Okay, Mr. Breen. Let's go in the house where we can be comfortable."

"Bubba," the deputy said. "I gotta get back on duty. I'll have a talk with my dad."

Bubba nodded. "Give him m'best." He turned to Breen. "C'mon, Mr. Breen. It don't smell anywhere *near* as bad in the living room."

"Actually," Breen said as they stepped

outside, "I didn't notice any smell at all. I was surprised."

"Yeah, I try to keep things pretty clean. A little sawdust, a little orange cleaner, a couple hundred Air-Wicks . . ." Bubba locked the garage doors behind them. A sign hung in the window of one of them, and he turned it around so that it read, "Pritchert's Automotive Performance Center. Next Week: *Grease!*"

As they entered the house, Breen looked around at the books and toys without comment, although he seemed a little uneasy. Bubba noticed this, but from what he'd seen, he figured that, like a lot of government people, he was probably uneasy most everywhere. He seated Breen on the sofa with the bay window at his back. "Mr. Breen, what can I get you? I've got several kinds of tea; Delaware birch beer, and some good old Virginny ginger ale. Plus," he added with a wink, "I got a six-pack of Anchor Steam beer I ain't popped open yet."

"Uh, no thank you, Mr. Pritchert. I'm 'on the clock,' as it were. I would like to try one of those birch beers, though."

"You got it, friend. You want a glass?"

"No sir, no need to bother with that."

"Ah, a real buckeroo. I like that in a Fed." He went to the kitchen and brought back not only two bottles of the Amish-brewed beverage, but a can of mixed nuts from the Virginia Diner. He set them on the low table between them and sat back in the Comfy Chair.

"Now," he said after taking a pull off the bottle and chasing it with a small handful of nuts. "What can I do for the F-Double-A?"

"We need to discuss your aircraft, Mr. Pritchert, in terms of FAA regulations. You have an unusual craft. *Very* unusual. I just saw it do some very . . . unusual things, and as you have plans to take it up into commercial flight lanes, it's necessary for us to certify it." He reached into his briefcase and pulled out a thick file. "You may not be aware of it, but you've been under government surveillance ever since you took possession of your craft.

Bubba leaned forward, intent and serious. "Tell me about this surveillance. I'm not surprised, of course, but I can't say I much like the idea."

Breen cleared his throat. "Yes. Well. We, of course, although we haven't had reason to contact you since you've stayed in ultralight ranges. But please understand that it's our job to monitor all aircraft in order to ensure the safety of the public."

"We'll deal with that later, Mr. Breen. Who else?"

Breen fidgeted nervously in his chair. "The FBI. You must have suspected it. I mean, you have an exotic aircraft—a 'flying saucer,' if you will—of unknown origin that uses unknown, possibly alien, technology. That's pretty high profile. They investigate *everything.*"

"It's not unknown, I know perfectly well where it came from. The XL-5 came from a grateful family on a planet called Thuntin." He waved a hand vaguely upward. "Way the hell out there somewheres. I did a job for 'em, and it was satisfactory, so they gave me a flying saucer as a present. If anybody wanted to know about it, all they had to do was ask."

"Perhaps they thought you wouldn't be forthcoming. The thinking in the intelligence community can sometimes be Byzantine."

Bubba nodded. "Yeah, that figures. Who else?"

"NSA, of course. They're champing at the bit to get to you, but we convinced them to let us get this straight before they leapt on you like starving wolves."

"I can hardly wait. Maybe they can explain to me how the damn thing works. I sure as hell can't figure it out."

Breen shrugged. "I don't know for certain, of course, but we heard that there was some activity up at Langley. And there are other, less public agencies who have expressed an interest. DARPA, for one."

"DARPA? Oh, great!" Bubba said, throwing his hands up in the air. "That's all I need, is gray-ops spooks running around the neighborhood askin' questions about my politics. That's as bad as those goddam tabloid assholes." He stood and began pacing. "Damn! I *knew* this was going to happen. Why didn't they just come to me? I ain't hiding anything, I'd of been happy to let 'em look at the damn thing all they wanted to. Hey, wait a minute!" He paused and turned to Breen with a frown. "What the hell are the NSA and CIA doing in this? They're not supposed to operate domestically."

"Mr. Pritchert. You have a *functional flying saucer.*"

Bubba scratched the back of his head and grimaced. "Okay, point taken."

"There's more. Both NASA and the Smithsonian contacted us several months ago with the idea that they might want to hire you. Since they knew that you couldn't take the job without an Administration classification, they asked us to do some research before they approached you." Breen shrugged. "That's why I'm here. I had to see the aircraft myself in order to make a final determination. My job, first and foremost," he continued in a serious voice, "is to make sure that public safety is addressed and secured, Mr. Pritchert. I can't let you take that craft into commercial flight lanes without certain knowledge that there's no danger to life or limb."

"I can help you there," Bubba said. "I may not know how the Fireball gets off the ground, but I can put her through her paces." He stood. "You hungry? There's a really terrific place not far from Richmond International that serves good ol' home cookin'. It's Wednesday, and the special is meatloaf."

"Well, I was planning to eat at the motel. . . ."

"Nah, can't let you do that. Sean's a nice enough kid, but he can't cook for squat. C'mon, it's my treat."

The trip from Central Garage to Richmond is roughly thirty miles as the crow flies, which is pretty much the way that Bubba Pritchert and his passenger made the journey. The trip was eventful. Along the way, Bubba performed a series of loops, inside rolls, outside rolls, dives, Immelmanns, right-angle turns, spins, tumbles, and abrupt stops. He stayed well out of commercial air space and, as best he could, explained to an increasingly white-knuckled Breen what he was doing and how the alien craft prevented them from experiencing the sometimes-violent effects of acceleration and deceleration. At one point he ran the saucer straight at a tall oak to demonstrate how the automatic systems would prevent collisions.

By the time they landed next to the flagpole on the specially reinforced roof of Yesterday's Restaurant (Bubba ate there frequently), Breen was red in the face and had gripped the hand-rest of his seat almost hard enough to leave fingerprints in the metal. His hair also looked three shades lighter, but that may have been a trick of the light.

"Well," Bubba said as he helped Breen stumble down the ramp to the roof, "what d'you think?"

Breen clutched desperately at the flagpole with one hand, breathing hard and shaking. "I have *never* been so . . . there's no . . . Do you have *any* idea. . . ?" He ran a trembling hand through his hair, pounded his fist against the flagpole, and then gathered himself with a deep, shuddering breath. "Mr. Pritchert. That was . . . *God*, that was *great!*" He laughed shakily. "I can't *believe* you did those things! You stopped dead at the top of a loop, you drove us through a river. . . ."

"That was the Mattaponi. Pretty, ain't it?"

". . . and that *tree!* It was just all so . . . so *cool!* Mr. Pritchert . . ."

"Bubba, please."

"Yes, of course, Bubba. And you call me Marty, okay? Bubba, I've flown in just about every form of aircraft known to man. I've piloted airliners, biplanes, stealth fighters, even an old Mustang my dad restored. When I was in the Air Force, I even flew an SR-71. I've flown a gyrocopter, for crying out loud. But I've never experienced anything remotely like what you did this afternoon. *Wow!*" He took out a handkerchief and mopped his brow.

Bubba smiled and nodded. "Worked up an appetite, huh? Let's eat. After you." He raised the trapdoor and they walked down the stairs into the restaurant.

It was comfortable and well lit, and the waitresses all knew Bubba by name. The two men were seated next to a window. There was a blue, late model Monte Carlo parked just outside with the number "16" painted on the driver's door. The walls of the dining room were covered with "Flying A" signs and racing memorabilia as well as old magazine ads. Just above them was a two-page spread showing a cat in an Army uniform advertising the C&O Railroad. In one corner stood an ancient Flying A gas pump.

"Interesting decor," Breen said, looking around.

"Yeah, the owner's dad used to run a Flying A station in Wisconsin. I worked for him for a while back when I was a kid."

Breen cocked his head. "I thought you were born and raised in Virginia."

"I was. Long story."

Their waitress brought Bubba a bottle of Carver's ginger ale without being asked and took their orders.

"Save room for dessert," Bubba said with a wink. "Rob's mom makes 'em herself."

The meatloaf was hot, juicy, and covered in gravy, with just enough tomato sauce to make it interesting. Bubba kept up a constant banter with the staff, and introduced Breen to the owner.

"Rob, this is Marty Breen from the FAA."

"Ah, they finally caught up to you, huh? Nice to meet you, Mr. Breen. Bubba take you for a ride in his flying machine?"

"I'll say he did. My hair is probably several shades lighter, but I wouldn't trade the experience for a gallon of Grecian Formula." The three men laughed.

"Rob races stock down at the Speedway, that's his Monte Carlo out front. You runnin' this weekend, Rob?"

Rob shook his head. "Nope, I'll be too busy here. We got a wedding party to cater." He smiled. "You doing anything this September?"

"Nothing planned, why?" Bubba asked.

Rob shrugged. "Chevy Rock'n'Roll 400 coming up. How'd you like for the XL-5 to be the pace car?"

Bubba was speechless for a moment. "You can do that?"

"I got some pull at the track. As long as you can do seventy miles per hour for a lap, and wear our colors, you got it made in the shade."

"Oh, man, that'd just be neater'n a 'skeeter's peter, Rob! I'm your boy. Just tell me where and when."

"I'll be in touch. You still out in the ass end of nowhere?"

"If by that you mean the fine municipality of Central Garage, yes, I am."

The waitress came back to ask for their dessert orders; Breen ordered the key lime pie at Bubba's suggestion, while Bubba himself asked for the strawberry cake. They finished, and both sat back completely satisfied. Their waitress cleared their table and brought coffee.

"So, Marty. What has the FAA decided?"

Breen sipped his coffee. "Well, we knew right away what it wasn't. It wasn't an airplane, seaplane, glider, rotorcraft, airship or balloon. We understood that even before I had the chance to inspect it."

"Okay, that's what it ain't. That's a *lot* of stuff it ain't. So, what does that leave?"

"I'm not quite done yet. It certainly fits Federal Aviation Regulation 1.1, a device that is used or intended to be used for flight in the air, but it's not an airplane since it doesn't depend on airfoils. And it's none of the other things that define more-or-less standard aircraft, and it certainly isn't a rocket." He took another sip of coffee. "We wrangled long and hard just to get that far, Bubba. There was a lot of debate, a lot of arguing, and at least one commissioner resigned over the whole idea of a flying saucer being licensed at all."

"All this just so I can tow an old car." Bubba shook his head ruefully. "If I'da knowed it would be this much hassle, I'da took up needlepoint."

Breen smiled. "Well, there is a classification we can use. It's temporary until a permanent certification is determined, but it'll allow you to fulfill your contract. But," he raised a finger, "there's a catch."

"Okay, I'll bite. What is it?"

"FAR Sec. 91.319, the experimental certificate. It's a limited operations certificate, and we would have to work out the details very carefully, but it can be done."

"And the catch?"

Breen drained his cup. "Well, mostly, you won't get paid."

Bubba stared. "What do you mean, I won't get paid? Hell, even *Sherpas* get paid!"

"I knew this would be a problem," Breen sighed. "You can't fly an experimental aircraft and carry persons or property for hire. Sec. 91.319(a)(2)."

"The *hell* with your Sec. 91.319(a)(2)! I got a contract with the National Air and Space Museum. With the *Smithsonian*!"

"Immaterial, really. Your contract will simply have to be renegotiated. Unless you agree to abide by the terms and conditions of the certificate, we can't allow you to fly over a densely populated area or in a congested airway." He placed the cup carefully back on its saucer. "I really am sorry, Bubba. It's the only way you can fly, and the only way we can grant you the certificate."

Bubba sat, fuming, tapping his finger against his coffee cup. "Shit on a stick. There's *got* to be some way. . . . Look, Marty, I'm a professional. That means I get paid, somehow or another. Now, the terms of the contract are such that I can't profit directly from anything I bring back. That only left the fee for the actual towing, and now you're telling me that I won't even get *that?*"

"I'm sorry."

"Damn! Hell! Sonofa*bitch!* Well," he said resignedly, "it ain't your fault, and I got no right to get angry with you. I don't have to like the situation, but it looks like I'm gonna have to deal with it whether I like it or not." He stood and grabbed the check off the table. "Come on, I'll get us back to the garage. Maybe I can figure *something* out."

The "something" was an emergency renegotiation of the original contract, called by Bubba and Kirby a few days later. The two men had frantically gone over every line of the contract looking for a loophole, but it was as airtight as a shuttle cabin. Nevertheless, they headed for the Smithsonian offices.

Kirby had been silent most of the way into DC, and as they mounted the steps of the Smithsonian Castle he hung back.

"Bubba," he said quietly. "You might want to get somebody else to handle this one. I'm, um, pretty outclassed here."

"You'll do fine as frog hair, boy. You double on sax."

"No, I'm not so sure I will. These guys are high-dollar attorneys with years of experience under their belts. I'm just a half-assed country lawyer."

Bubba stared at him. "Last I checked you had the full complement of ass," he said, "and you got a degree in international law from the goddam Sorbonne!"

"Yeah, well," Kirby muttered as he opened the door, "France is a country, isn't it?"

The mechanic laughed as they entered the building. "C'mon, Kirbs. Let's go do some bidness."

They made their way to a conference room on an upper floor. There was the usual furniture—a long table, expensively comfortable chairs, and lawyers. Before anyone else could say anything, Kirby cleared his throat and said in an authoritative voice, "Good morning, gentlemen. As I'm sure you already know, we're here to renegotiate the terms of the contract previously submitted by you to my client. As you know by now, the situation has changed, so the terms of the contract must be changed to reflect that. One aspect must not be changed, though; my client will be accompanied by his companion, the artificial intelligence referred to therein as 'Mike.' This is non-negotiable. With all that in mind, and with the understanding that we may very well be here for a while, can we please get some coffee?" With that, he sat in the chair at the end of the table and snapped his briefcase open.

There was a silence in the room as the other lawyers glanced at each other. One of them coughed. Down at the other end of the table, a tall, dignified man with an almost totally bald head and aquiline features touched a button on the phone beside him and said, "Mark? Could you send in some coffee and pastries, please? Thank you." While they were waiting, introductions were made and hands were shaken. The tall man was the representative of the Smithsonian/National Air and Space Museum, Herbert Lawler. He and Bubba smiled at each other, but said little.

Several hours went by before the new situation could even be stipulated by all, hours of wrangling and hammering on minute points of law and statements of intent. At one point, Kirby and the other attorneys were almost toe-to-toe over something vital but microscopic, and Bubba decided that enough was too much. Lawler was looking similarly trapped. He caught Bubba's eye and motioned to the door with his head. Bubba glanced at the lawyers, then nodded and stood up as if to stretch. Ambling to the door, he was through it and into the hallway in the blink of an eye. After a few seconds, Lawler joined him.

"You guys got a jakes on this floor?" Bubba asked.

Lawler shrugged. "It wouldn't be very Smithsonian of us if we didn't, would it?" he said.

"C'mon, then. I got to wash my hands like a race horse." The two men walked down the hall in silence until they came to a door marked "Lounge." Lawler keyed the door open and held it for Bubba.

Once inside, Bubba looked around. There was a small refrigerator, several tables with sturdy chairs, a couch, several armchairs, and a microwave oven. It was well lit without being garish, and obviously designed for comfort.

"Not bad," Bubba said. "I was expecting . . . well, something a lot less elaborate."

"If you want, we can go across to Natural History and I'll show you our colony of Madagascar roaches. You can even pet one, if you like."

"Thanks, pass. A bug is a bug to me."

Lawler waved his guest to a chair. "How about a root beer?"

"What kind you got?"

The tall man rummaged in the fridge, rattling bottles and moving things around. "Looks like we've got Route 66, A&W, and a couple of bottles of Rat Bastard." Seeing the surprised look on Bubba's face, he added, "A couple of us really like it, so we try and keep all the lounges stocked."

"Rat Bastard Root Beer? Oh, I *gotta* try that." He took the bottle he was handed and opened it with a twist. Lawler opened a can of A&W. They nodded to each other and raised their respective beverages in salute.

"So," Lawler said, settling into his chair and taking a drink. "What exactly do you want?"

Bubba cocked his head and eyed the man. "I figure you know that already, or we'd still be back in that little room with the raptors." He knocked back a slug of root beer, icy cold and as pungent as a stolen kiss.

"Okay, so I've got a pretty good idea what you want. You already know what we want. How do we get to where we both get it?"

"Well, we could always just write something that said 'We the undersigned hereby agree,' and then sign it."

Lawler nodded thoughtfully, pursing his lips. "Yes . . . yes, we could do that." He shook his head. "It would never hold up, of course."

"Naw, I s'pose not. Hmph. Okay, let's look at the whole thing. You want the Rover back so you can get the people excited again, and they'll annoy the hell out of their congress peeps, and NASA can nail down a tasty appropriation. Right so far?"

"Perfectly," Lawler replied, taking another drink.

"I don't know, Mr. Lawler. I'm not sure it's right to bring it back. I think it ought to stay up there, where it belongs."

"Why?"

"Because that's where it was meant to be, in that big crater with the flag. We went to a lot of trouble to put it there, and it just doesn't seem right to haul it back. What if," he leaned forward as he spoke, "I brought one of the others back? They're pretty much alike, aren't they? Wouldn't that be just as good?"

"Would it have been 'just as good' if we exhibited the second plane to fly the Atlantic? Or a bomber 'pretty much' like the Enola Gay?"

Bubba frowned. "Granted, but who would know? Would it really matter to someone looking at it in a museum?"

Lawler sighed. "I would know. *You* would know. And yes, it would matter; anyone who would go to a museum or come to a traveling exhibition cares enough about it that it *would* matter."

"But if it matters . . . if it matters that much . . . won't people be willing to bust their asses to go up *there* to see it? Wouldn't that, in fact, be better all around?"

Lawler sighed again. "Realistically, that's not going to happen. Not in our lifetimes, not, perhaps, in this century. No, the place for it is *here* where there's a chance it will inspire people to be enthusiastic about going into space again. We can mount a permanent exhibit around it as the centerpiece, or create a mobile exhibit that would take it to science museums and schools all over the country." He spread his hands. "I think you already know this, Mr. Pritchert. Why are you so reluctant, I wonder?"

Bubba was silent. "It's . . . hard to explain, Mr. Lawler."

"Herb, please."

"Okay, Herb. And you call me Bubba." He closed his eyes. "You're asking me to manhandle something that is more important to me than anything except maybe the Bill of Rights. Or the Eagle, for that matter. The others, well, they're just cars. But this . . . *this* is the first issue of *Amazing Stories*. This is the Gutenberg Bible, the Mona Lisa. It's one thing to tow somebody else's Mercedes or Bust-My-Windows, I'm insured for that. What happens if I drop *this?*"

Lawler smiled slowly. "Mr. Pritchert—Bubba. You're a professional. We checked you out. You've never dropped a vehicle in your career. You've hauled old junkers with the same degree of care with which you towed your late aunt's Rolls." He reached out and placed his hand on Bubba's arm. "We trust you, or you and I wouldn't be having this conversation."

Bubba sat and thought. "Okay. Okay. I'm still not sure, but that's the job you're hiring me to do, so that's the job I'll do. Okay."

"Glad that's settled. Now we know what my side wants. How about you?"

"I want . . ." Bubba paused. "Hell, I never put it into words before." He sat forward, holding Lawler's gaze. "I want the whole thing, start to finish. I want the wonder, the excitement, the whole twenty-seven feet. I want the Last Frontier, Herb." He sat back.

Lawler placed his can on the table in front of him and pushed it forward with one finger. "What you want is about forty years out of stock," he said quietly.

Bubba shrugged. "As close as you can come, then." He emptied his bottle and placed it close to the A&W can on the table. "I also want something for a special friend of mine, something that will be of enormous help in this little project of ours. I wouldn't mind being able to bring back a couple of rocks, too. *And* I want to get paid."

"The FAA says that can't happen."

Bubba grinned slowly. "I think I know a way it can." The two men put their heads together. Presently, they both sat back and laughed.

"I think this is all workable, Bubba," Lawler said. "I don't think we'll have a problem with the wheels. We'll base it around a two-wheel robot base, I think, unless you have any objections. I know a company that will sell us one cheaply enough, or perhaps even donate it for promotional considerations. Let's see, their RMP is a two-wheeler based on the same principles as their upright models, without the handlebars, but with a platform . . ." he began sketching rapidly on a paper towel, then continued, ". . . to which we can add a superstructure that will take both the arms and the cameras. Easy enough. The robotics will be even simpler, they'll come pretty much right off the shelf. It helps that your friend . . . ?"

"Mike."

". . . that Mike is capable of controlling and coordinating the gyrostabilizer systems. Which reminds me, the platform has a narrow operating range that doesn't include moon temperatures. Can Mike handle that?"

Bubba nodded. "Yeah, he worked that out after I let him know I was gonna get him wheels. He'll vent excess heat through the stasis field as needed. Walk in the park for him."

Lawler shook his head in wonder. "A real artificial intelligence. Boy, what I wouldn't give to lease him for a year."

Bubba frowned. "Mike isn't for rent, Herb. However, he might do a few favors for a friend. At a salary of, say, a dollar a year."

"We'll talk about it later," Lawler said, then looked thoughtful. "How do you plan to get the Rover to the Right Coast from the Wrong Coast?"

"I'll lease a flatbed tow truck in Landers, California. Friend of mine, name of Kermit—electronics whiz and a charter member of SauNA—will fly there and drive it to Giant Rock. We'll take turns driving it back."

"What is this sauna of which you speak? Surely not a steam bath."

"'Saucer Nuts of America,' Herb," Bubba replied. "A little organization I started and of which I am President For Life."

"Oh. Um, how does one . . ."

"No problem, m'boy, I have came *prepared.*" Bubba reached into his bag and produced a bundle wrapped in brightly colored paper. "T-shirt, membership card, and decoder ring. You are SauNA member number, uh . . . let's see, number 3.14159. How's that suit you?"

"Right down to the ground. Thank you, I'm honored. And now," he said, tucking the bundle under his arm, "it's time we got back to the shark pit." As they stood to leave, Lawler offered his hand, and Bubba shook it warmly.

"Let's go poke some lawyers with a stick," he said.

"I think I'd enjoy that," Lawler said with a smile.

When they reentered the room, the discussion had advanced to whether or not an artificial intelligence could legally be included as one of the Party of the First Part, or if it should be listed separately. The sticking point seemed to be whether or not Mike could even be considered a person under the law.

"Gentlemen?" Lawler said just loudly enough to be heard over the ongoing discussion. "Gentlemen, attention, please." Gradually the room quieted, and all eyes turned to him. He held up a stack of napkins. "Mr. Pritchert and I have worked out the give-and-take. We are agreed. Your job," he said, looking at each of his legal team in turn, "is to implement this in detail."

"But . . ." one of the lawyers protested. "We don't even know what you've agreed to."

"Herb," said the head of the legal department, "do you really expect us to create a new contract out of cocktail napkins and . . . is that a paper towel?"

"Yes, it is," Lawler said. "And yes, I do."

The lawyers muttered amongst themselves. Kirby nudged Bubba and said, "Erm . . . what might you have gotten us into? Is this even going to be valid?"

Bubba shrugged. "You'll have to make sure. Lawler and I are good to go, I can tell you that."

"Okay," Kirby said with a sigh. "I'll do my best."

"You always do."

Lawler rapped on the table with his knuckles. "Gentlemen, I don't think you fully understand. What I've handed you is exactly what Mr. Pritchert and I have come to an agreement on. I want it written up, with no additions or changes, and on my desk by the end of business Wednesday. That's two days from now." He dropped the napkins on the table. "The basic terms will be as follows: first, we will guarantee Mr. Pritchert payment in the amount of fifteen thousand dollars."

"Standard mileage charge for a cross-country tow, gentlemen," Bubba said.

One of the junior lawyers interrupted. "But the FAA . . ."

Lawler raised a hand. "The FAA restriction only applies to Mr. Pritchert's unique, er, conveyance. The payment will be for a land tow from California to Maryland." There was an instant murmur of voices around the room. The head of the legal department looked interested. "Due to circumstances beyond his control," Lawler went on over the muttering, "Mr. Pritchert cannot fly the Rover directly to the Garber Center in Suitland. He says he can guarantee the Rover's safety, as well as quarantine requirements, to my satisfaction as well as NASA's.

"Second, in cooperation with NASA, who clearly has a vested interest in the success of this project, we will supply the hardware and manpower necessary to equip Mr. Pritchert's, er, assistant with mobility and manipulatory apparatus so that he can actively aid in the recovery of the Rover, specifically a Segway® device, two stock robotic arms, and a pair of digital cameras." There was more muttering. "Third, I think we can see our way clear to allowing Mr. Pritchert to bring home one or two moon rocks, as long as he doesn't auction them off online."

"Oh, this is just ridiculous," one of the junior lawyers snorted. "Mr. Pratchett . . ."

"Pritchert," Lawler corrected sharply.

"Sorry, Mr. Pritchert. Why on earth should we agree to any of this? What makes *you* so special that you deserve these absurd considerations?"

Bubba grinned slowly and leaned toward the man. "Because, sir, as I have been reminded a number of times in the past few days, I have a functional flying saucer." He sat back and folded his hands over his chest. "What have *you* got, boy, a Big Wheel?"

Lawler cleared his throat. "Right, that about does it. Wednesday afternoon at the latest, please," he said, and drawing himself up to his full height, bald head raised high, and Roman nose thrust forward proudly, he pointed at his chief lawyer and said, "Make it so, Number One."

There were groans from the back of the room. "God, I hate it when he does that," one of the lawyers said under his breath. The legal head suppressed a smile. "I'll see to it right away, Captain," and left the room, trailing the other lawyers behind him.

The next few weeks were as busy as a Frenchman's sombrero. To protect themselves from possible liability, the lawyers insisted that their civilian contractor be given a complete medical checkup. He was subjected to the usual battery of tests, poked, prodded, questioned on matters he would ordinarily have felt embarrassed to discuss with strangers, and otherwise handled like one of Clint Miller's beef cows on auction day. Bubba passed with flying, as it were, colors.

His next ordeal was much more pleasant. He was flown to Johnson Space Center where he was thoroughly measured, and the determination made that he was close enough in size to ex-mission specialist "Ox" van Hoften to be able to use his Hard Upper Torso, despite its having been out of service for a decade or so. "Don't worry about the gasketing," a technician told him. "It's been refurbed. Doc Ox passes his good wishes along, too." The leg and arm sections could be taken off the rack.

The suit was extremely heavy under full gravity, so there were several technicians there to help him into it in the Neutral Buoyancy Laboratory. "Whoo, boy," Bubba said as he sat while a NASA fitter helped him pull on the LTA. "I feel like I'm on *Queer Eye for the Straight Guy.* These come with pleats?"

Without looking up, the technician said, "Don't worry, we'll do Carson proud. Just don't try and 'jeuge' the sleeves."

Then it was into the huge pool. As a rule, for each hour of planned EVA, an astronaut spends eight in the water; in Bubba's case, since he'd never gone through the astronauts' "boot camp," they gave him more time. Within several days, he was almost as comfortable working in the suit under a simulated one-sixth gravity as he was in coveralls in his own garage. It left him feeling tired, but elated.

The next step was less pleasant, ultimately. On his next to the last day at Johnson, they took him up in the C9 Skytrain II aircraft, known by all who've ridden in it as the Vomit Comet. A medic gave him Dramamine by way of preparation. "Am I really gonna need this?" Bubba asked.

"Pretty much everybody does. There are those, in fact, who blow chunks on the first dive." He grinned savagely. "No backsies. They have to stick it out for the whole ride."

"Oh. Okay." He swallowed the pills. "I brought these, too," and he reached into his pocket and pulled out an Altoids tin. He opened it and showed the tech the small brown pills it contained. "Ginger. Worked for the Mythbusters."

"Hey, knock yourself out," the technician said. "Not literally, of course."

The big C9 took off and climbed, seemingly endlessly, until it reached thirty thousand feet. Then it dropped. For the next half minute or so, Bubba Pritchert of Central Garage, Virginia, floated about the cabin whooping like a ten-year-old and bouncing off the padded walls, somersaulting, spinning, and flapping his arms like a madman, while the technicians tried desperately to keep out of his way.

The first ten parabolas were exhilarating. The second ten were exciting. The third ten could be described as "interesting," if only from the standpoint of making a carefully detailed list of everything he'd had to eat in the past week. Before the fourth double-quint, he swallowed two of the ginger pills, which he managed to keep down in spite of himself. The fifth decade—which certainly seemed to last that long—made him regret having swallowed anything at all since he had been nine years old, but he managed to keep everything pretty much in place, although he made a mental note to cancel his dinner plans. For the next five years, if necessary.

In the meantime, the techs on loan from NASA took Mike in hand and created his robotic body. As Lawler surmised, the Segway company was more than happy to donate one of their RMP models for the purpose in exchange for promotional rights. The unit was delivered as stock, with the exception of a set of the cross terrain tires they used for their X2 model, and the techs went to work adding not only the assembly that held the arms, but a case into which Mike would fit securely, with all connections necessary to control the stabilizers. To this end, Mike himself was able to coach them as necessary.

The RMP, specifically designed as a two-wheeled robotic platform, was chosen for its sturdiness and range. It was doubtful that Mike would need the maximum speed of 12.5 mph, but the battery life would be more than adequate for their purposes. As the RMP didn't have the central pillar found on the other Segway vehicles, a hydraulic system—a robotic "spine"—was installed, which could raise and lower the arms by eighteen inches. Mike's optics were upgraded as well, to twin full-spectrum digital cameras. Added to the top of the column, they not only swiveled, but could be extended both vertically and laterally, and focused as a unit or independently.

It took a number of hours for the AI to learn to handle the five gyroscopes that enabled the unit to remain stable, and to coordinate the arms and eyes, but once he had it, he'd never lose it. However, while rooting through the programming, Mike found an anomaly; in various places throughout the code, he kept running into the same hex string over and over again: 0xEB90.

When he brought this to the attention of the Segway tech, the man said sheepishly, "Yeah, we do that a lot. It's an inside joke, the least-likely sequence of bits used in data communication. It can't really be used, no matter what algorithm you design, so we kind of sprinkle it around like salt." He laughed. "NASA uses it as a synchronization header when they program the shuttle. For us, it's a little like 'Kiljoy was here.'"

"Kil*roy*."

"Him, too."

After a day of resting and watching old Universal horror movies on cable in his hotel room, Bubba and Mike flew back home to prepare for the trip.

Of course there was a crowd. A significant fraction of the population of Central Garage, in fact, along with a contingent of state and county police, representatives of NASM and the FAA, Miss King William County, the Frog Level Rescue Squad (on loan from Caroline County just in case), the Hamilton-Holmes Middle School marching band (performing a stirring rendition of "Louie Louie"), and a reporter/photographer team from the Richmond *Progress-Dispatch* who looked only mildly interested.

The scout ship sat flat on the ground, draped with red, white and blue bunting. Mike was already installed aboard, his new body stowed safely until they reached their destination. There were a few folding chairs on both sides of the ship, and a set of bleachers facing it; more than a few spectators were already seated, munching peanuts and corn dogs, waiting for the main event.

The reporter showed his credentials to the police, and walked over to the beauty queen.

"So, why are you here, miss?"

She waved her Pepsi bottle at the ship. "Bubba's gonna go to the Moon," she said. "Dunno why, he hasn't said, but I like watchin' him fly around in the Fireball."

"And you really think he's going to go into space in that . . . thing?"

"Oh, sure! He flies it up to Richmond all the time, why not there? I heard he's even been to Newport News in it," she whispered conspiratorially, "but I'm not sure."

The reporter shook his head and moved through the small crowd, his photographer following along behind. "I don't know what we've got here, Danny," he said to the cameraman. "It's got to be a hoax of some kind, but there are real cops over there, and unless I'm mistaken, there are two guys over there with 'Fed' written all over them." He frowned. "What do you know about this? I mean, I'm new, they parachuted me into this cold, but you've been around for years. Don't we already have a file on whatever this guy is supposed to have been flying around Richmond? And maybe Newport News?"

"Nothing I know of, Scoop," the photographer answered. "Maybe the Government hushed it up."

"Yeah, right, 'Flash.'" He turned as someone tugged on his sleeve.

"Hey, mister, you a reporter?" The speaker was a small, wiry man in his sixties, face grim and eyes flashing. "You want the straight dope on that Pritchert guy?"

The reporter took out his notebook. "Sure, old-timer. What's your name?"

"They call me Big Lester, Lester Beason. That's B-e-a . . ."

"Right, I've got it. What can you tell me about Mr. Pritchert?"

"Oh, I can tell you plenty," the old man said. "I know all about Mister Smarty-Pants Bubba Pritchert."

"Please, by all means, tell me," the reporter urged, motioning the photog to be ready to get a picture of the man. There might be some kind of story here after all—a con game, or some crazy New Age religion, maybe.

"Well, first of all, that ain't even his real name. He's got *four* names, not like other folk."

"Are you telling me that Pritchert has four aliases?"

"I don't know about no 'aliases,'" snapped the old man. "He's got four first names and a last one." He shook his head. "That ain't normal."

The reporter sighed inwardly. Sometimes, getting to a story was about as easy as regrouting a bathroom. "What about that thing over there? What do you know about it?"

"Huh. I know he oughtn't to be flyin' the damn thing all around like he does, is all. Disturbin' honest folks that's just trying to put meat on the table."

The reporter stared. "I'm sorry?"

"Well, he just oughtn't to go buzzin' me and my buddies, that's all. Comes from right outta nowhere, he does, flyin' around, scarin' the deer . . ."

"You mean," the reporter said, pointing at the Fireball, "that thing actually *flies?*"

"I'll tell the world. Up and down, back and forth, messin' around and spoilin' any chance we got of bringin' down a buck." The old man spat on the ground. "So what if we use a few lights? Don't I got a right to feed my family?"

The reporter flipped his notebook shut and looked at the old man. "So go to Food Lion." He walked away. "Jesus, Danny," he said just loud enough for his companion to hear. "Everybody's in on this. I can't believe it, they're all in on this . . . joke, or hoax, or whatever."

"Looks like it, Scoop."

"Danny," the reporter said, more than a little exasperated. "Stop calling me that. We're not in a remake of *His Gal Friday,* okay?" He began walking towards Bubba, who stood near the ship wearing his Liquid Cooling and Ventilation Garment. "Mr. Pritchert, can I ask you a couple of questions?"

"Sure, son," the mechanic replied. "Knock yourself out. Not literally, of course."

"What exactly are you doing here today?"

Bubba grinned. "Goin' to the Moon, boy. Why do you think I'm wearin' this funny suit?"

"You're going in . . . that?" The reporter waved his notebook at the ship.

"Can't get there in a Hummer."

"Okay, fine. Can you tell me why you're going to the Moon?"

Bubba said, "Just be patient, and all will be explained. Give me a minute to do this with the right amount of drama," and turned away, pulling on a tight-fitting full-head cap from which wires dangled.

The reporter shook his head. "I still don't know what we've got, Danny. But have your camera ready just in case, okay?"

"Always, Scoo . . . uh, Ted."

Bubba stepped up on top of the ship, fists on his hips, legs akimbo, and his helmet under his left arm. He looked out at the gathered multitudes. "Y'know, Mike, I really should be wearing gray leather coveralls with a big, shiny wristwatch."

"Um, why?"

Bubba shook his head. "Doc Smith. Lensmen. Never mind, Frank R. Paul would know." He continued in a louder voice, "Good people of Central Garage, King William County, and Points West! I, your wizard *par ardua ad alta*, am about to embark upon a hazardous and technically unexplainable journey into the outer stratosphere to confer, converse, and otherwise hobnob with my fellow, er, gearheads." There was general laughter.

"But serially, folks, this shouldn't take too long. All I gotta do is fly to the Moon and tow back a car. Hell, that ain't hard, it's just right up there." He pointed skyward, then squinted. "Somewhere. Mike, we got an auto-club map for this trip?"

"We do not. The very nice lady at AAA was just as sorry as she could be, but those particular roads apparently haven't yet been built, and Google Maps doesn't show enough detail."

"Boy, you got an answer for everything, don't you? Anyway," he said, turning back to the crowd, "we'll be takin' off directly. Don't cancel my paper or anything before I get back, and make sure you feed my cat."

A voice in the crowd called out, "You don't got a cat!"

"So feed somebody else's. They ain't got opposable thumbs, and can't work the can opener by themselves." There was more laughter. He keyed the door open and went in.

"You know, Mike," he said, as he settled into the pilot's seat, "I've never really been able to open 'er all the way up before. Hell, I don't even know how to tell how fast we're going, I just watch stuff go past outside. Now if I push this joystick all the way forward, that's floorin' it, right?"

"Well, yes, but you shouldn't . . ."

"Damn, this is exciting. I mean, I've worked on racing stock most of m'life, but I've never actually raced."

"Bubba, please don't . . ."

"Took cars on test laps a couple of times, o'course, but never got 'em much above a hundred. Didn't really trust my drivin' skills. But I can't wreck in this thing, right? And we're programmed to get to the Moon no matter what, right?"

"That's true, but don't let that . . ."

"So what th' hell, boy! Let's see what the USS Right Honorable Fireball XL-5's got under the hood."

"No, Bubba! Don't . . ."

Bubba pushed the joystick all the way forward. The Moon swelled to fill the forward port within seconds. *"Jesus Christ!"* Bubba cried, throwing his hands in front of his face. "Why the hell didn't you warn me? I damn near filled my Maximum Absorption Garment."

Static burst from the screen. "I tried, Bubba, I tried."

Back on the ground, the crowd was whooping and whistling. Miss King William County looked like she was about to faint, and the two suits were racing to their cars, talking furiously into their sleeves. The band was playing "In the Sunshine of Your Love" and marching gaily back to their bus.

The two newspapermen stood spellbound, mouths open. "It . . . it just . . . disappeared," the reporter whispered, his voice awestruck. His companion made a squeaking sound that was barely audible. "Tell me you got that, Danny. *Please* tell me you got that!"

Danny shook his head slowly. "Didn't have time. It was there, and then it wasn't, and there isn't anywhere down here for it to be."

"You didn't get it at *all?*"

"Uh-uh. Too fast, Ted." His face fell. "Biggest goddam thing I'll ever cover, and it happened too damn *fast.*" He began sobbing quietly.

"Well, we have to make sure, I guess. Let's check out the area around where that . . . that damned spaceship or whatever it is was sitting." They examined the ground around the take-off point carefully, but there were no trap doors, no mirrors, nothing.

Ted sagged. "They'll never believe us," he said sadly. "Not in a million, billion years. We might as well not even file. C'mon, Flash," he said, patting the weeping photographer on the shoulder. "Let's go find a motel with HBO, and a lot of beer. We're not going back home tonight."

The cameraman sniffed. "O-okay, Scoop."

A bit closer to the Moon, the reaction wasn't much calmer.

"Great sizzlin' wor bar!" Bubba clutched his chest and paused to catch his breath. "I ain't felt nothing like that since the choir-mistress taught me to sing bass." He shook himself and settled back in his seat. "Mike, how long did it take us to get here?"

"Five point eight seconds. Give me a minute to vent some heat; we built up just a little friction on the way up." He opened a few holes in the field to let the heat escape.

"Huh! How long would it take us to get to Proxima Centauri?"

"Longer. Why would you want to go there, anyway? There's nothing interesting in the entire system aside from a couple of low-quality eating places."

"Oh, far be it from me to eat in a diner. How's their coffee?"

"They don't have any. Not even an equivalent."

"Don't matter, I don't like coffee anyway. Take us in, Mr. Sulu."

They planned to set down close to the Rover, but far enough away to leave the surrounding ground as undisturbed as possible. Mike argued that closer was better, but his companion insisted. "Bubba, our propulsion system won't leave traces the way theirs did. A shallow depression in the dust, and that's it."

"No, we'll do this my way, Mike. Nothing gets disturbed. It ain't gonna hurt me to walk a few yards." And that was that. It took a bit of searching, but they managed to find a spot without tracks or prints and settled there.

Mike cut the drive. Bubba keyed the radio and said, "Houston, we're down and safe. Preparing to EVA in . . . oh, I dunno, ten minutes? Over."

There was silence, and Bubba was about to transmit again when the speaker cut in. There was a considerable amount of noise in the background. "Roger, Mr. Pritchert. And roger your EVA. How's the weather up there, over?"

"Rainin' like hell," he replied. "Can't hardly see the white line. Over."

"Roger that. By the way, there's a control room full of technicians here who seem to think something remarkable has just happened. We lost you for a few seconds, then telemetry showed you were . . . well, very close to your destination, over."

"Naw," Bubba replied. "Nothin' so much of a much. I may have squeezed through a light here and there, but that's just the way we do it at the Martinsville Speedway. Over."

"Roger. So, how's your food supply? Got enough Chinese food, over?"

Bubba's eyebrows shot up into his hairline. "Oh, you heard that, huh? Um, over."

"Roger."

"Damn. Man ain't got no privacy anywhere." He opened the mic again. "Roger, Houston, keep in touch. You know how your mother worries, over." He sat back, fingers drumming on the armrest. "Well. Well." He drummed some more.

"Bubba?"

"Guess it's time to go out there and do what we came here to do, Mikey." Still he didn't move, just sat there, chewing his lower lip. Now that the moment was upon him, he was oddly reluctant to go outside. It wasn't fear. The suit was already well tested, he'd been briefed on the peculiarities of working in low gravity, he'd trained in the NBL pool, and in any case, this was something he'd dreamed of doing most of his life.

And, of course, that was it: he was going to fulfill a dream, and there were inevitable uncertainties. Would the reality live up to the dream? Would it be like the old stories he loved so much, or just a prosaic substitute? Would it be even more than he expected? Was he, in fact, worthy of his dream? And finally, what would be left for him after?

"I hate to bring this up, but our air supply *is* relatively limited."

"Don't rush me, Mike. I gotta nerve up for this."

"Why? We're just going out on the Moon. It's not much different from the practice you did in the pool."

"The hell it ain't. All right, I'm goin'." Removing Mike from his slot in the ship's control panel, he carefully fitted the little box into the new robotic torso, making sure that Mike was completely connected. Then he suited up, clamped his helmet to the neck ring, and tested the seal. Once he was satisfied, he entered the little airlock and cycled it.

Edgar Allen Poe Hudgins Pritchert stepped out onto the surface of the Moon. Where his boots touched, dust rose lazily in the low gravity. He could almost feel the grit beneath the thick soles, but he knew this was an illusion. He breathed deeply, wanting to smell or taste something other than the air supplied from the tanks on his back, knowing full well that he never could—that *no* human ever could.

Words swirled in his mind, words intended to commemorate this event in his life, words that he knew deep in his heart were unnecessary: it wasn't as if he'd ever forget this moment, after all.

Instead, he simply stood quietly, turning slowly in place and looking, desperately trying to pack into the few minutes he had here a lifetime's aspirations. Oh, he could always come back. He could get the clearances, the permissions, file the flight plans. But no matter how many times he might return, there would only ever be one First Time.

His eyes blurred, and his hand automatically brushed against his faceplate in an attempt to wipe away tears. His chest and throat ached, full to bursting with wonder and awe. The Moon! He was on the *Moon!* Somewhere under his feet were the remains of the Selenites, and Professor Cavor's desiccated body; somewhere here, or perhaps over there, the mortal remains of Delos D. Harriman sat propped against a rock, marked only by a poem scrawled on a shipping tag and pinned to the Lunar dust by a knife.

Over there had been a Fall of Moondust; there, just over the horizon, a mysterious monolith with a ratio of one by four by nine had been discovered at Tycho. And just past those ridges, not so very long ago, the Moon had been Hell. And there, and beyond *that*. . . .

Not far from where he now stood, mute and inglorious, Neil Armstrong had jumped lightly off the Eagle's ladder and left footprints in the Lunar soil that no one else could ever fill. That those prints were erased when he and Buzz Aldrin blasted off to rejoin Michael Collins in orbit was irrelevant: they would never be eradicated from history—from his soul. This was sacred ground, here in Mare Tranquilitatis; eleven more men had followed Armstrong and Aldrin and left their marks all but indelibly, but Bubba Pritchert of Central Garage was the first in more than thirty years. He stood now where his heroes once had, far too long ago. The enormity of it shook him to his core.

He reached down and ran his glove through the soil. Picking up a handful, he raised it to eye level, working it gently between his fingers as if he were testing loam. He opened his fingers slowly and let it go. It dropped slowly, glittering in the harsh sunlight, like nothing he'd ever seen. *A Fall of Moondust,* he thought again.

He bent his knees carefully, making sure he kept his balance, then straightened them. He rose a few feet into the air and hung there for a moment, his heart pounding in his chest and the hairs on his arms standing so straight it felt like they would push through his sleeves. Slowly he came back down until his boots touched the soil. The *Moon.*

And when words finally came, they were unplanned, unconscious: "Dammit, Gus! *You* should've got here. You and White and Chaffee. Y'all busted your humps to make it. Me, I got a free ride. Y'all's footprints should be here, not mine."

The Earth hung high above him, beautiful and terrible, and he stared at it for what felt like an eternity before he turned back to open the storage locker that had been attached to the scout craft and began assembling the winch and crane.

Something touched his back and he jumped, held to the surface only by his hands on the crane's framework. It was Mike, who had followed him onto the Moon after shutting the ship down and sending word back to Earth that they were ready to start loading the Rover.

"God*dam,* Mike, you scared the bejeezus out of me! I near soiled myself, and I don't even want to think about what that would do to the warranty on this suit."

"Sorry. I knew you were going to need help with the crane, so I came out. I was careful not to roll over your footprints, by the way. I know they mean something to you."

Bubba continued to bolt the framework together for a moment before answering. "Thank you, Mike. I appreciate it. That's pretty good thinking for a genius with your limitations."

"'Limitations'? I have 'limitations'?"

"Later. I want to get this vehicle secured, and then break the crane down so we can get home."

"Later it will be, then," Mike replied.

They walked the short distance to where the Rover had stood for over thirty-five years, patiently waiting for someone to bring it home. Once again, Bubba felt the wonder he'd felt when, in July of 1969, he had watched from his easy chair as the Eagle landed in a place he never thought he'd be. He reached out his hand to touch it, then drew it back.

"Nobody will know."

"Huh?" Bubba was startled.

"If you bring back another one," Mike said. "They're all pretty much alike, and I know you've been uncertain over whether or not this is the right thing to do. What are they going to do, come back up here and check on you?"

Bubba reached out again, this time making contact with the seat back. "Lawler was right, Mike. I'd know. You'd know. There are ways for them to check, serial numbers and such."

"Yes, there are. But I know you've been uncertain over whether or not this is the right thing to do," Mike repeated. "I wouldn't tell."

Even through the thick glove, Bubba felt a thrill go up his arm as he ran his hand along the smooth metal of the Rover. This was it, the first one. Didn't it deserve to be left here, where it had rested for three and a half decades? Wouldn't it be easy enough to convince people that one of the others was this one?

"No," he said at last. "Let's leave aside for the moment that there are plenty of differences between them. Let's forget that I gave my word to bring this one back, and signed my name to it." He drew back his gloved hand and held it up in front of his faceplate, turning it first one way then the other.

"People are going to travel far to see this one, because it was the first, the original. They're going to stand in front of it, and feel wonder. Some of them are going to try and sneak out their hand to touch it, and if they do, they're going to feel the same thrill, the same buzz, that I just did." He dropped his hand back to his side. "It ain't right for that to be a lie." He began moving the framework closer to the Rover, and Mike used his new arms to help position it.

"I knew you'd say that, or something like it," he said. "We picked the right man back in 1958."

"Yeah. Yeah. Hope you never have reason to think otherwise. C'mon, let's get to work."

They worked slowly in the low gravity, being careful to remember that their mass was unchanged; they were especially cautious when moving the crane into position near the Rover. The decision had been made not to fold the Rover back into its original configuration, but to transport it as it was. It took time and effort—Bubba was breathing hard by the time they were done—but finally it was securely supported by the chains hanging from the framework.

"Let's take a break," he said. "I need to sit down and rest a bit."

"We can take the time to refill your air bottles, too," Mike said. "Once we're back out here there's no way to do it, and if you run out of air I don't know if I can drag you back before you turn blue."

"Damn good thinkin', little buddy. Now I remember why I keep you around." They returned to the ship's airlock, where Mike connected his tanks to a compressor and proceeded to refill them. Bubba took off his helmet and sat with his eyes closed, trying to regain not only his breath, but his equilibrium as well. "It's a job," he told himself. "Just another job. Do it clean, do it well, and we'll handle the sheer vastness of the thing later." He took a deep breath, stretched, and cracked his knuckles. "You about done there, Mike?"

"Yes, I topped off your tanks. You're good for another few hours."

"Then in the words of the ancient Oriental philosopher, 'Let's get 'er done!'"

It was, of necessity, slow going, but both man and machine were more than capable of the methodical work needed to safely raise the Rover, move the XL-5 under it, then lower it again so that it rested in the "cargo hold"—the cavity behind the pilot/passenger cabin Bubba had prepared just for that purpose—and was thus protected from the vagaries of acceleration by the inertialess drive. From there it was just a matter of securing the vehicle so that it wouldn't budge, and disassembling and stowing the winch and crane.

Mike set the stasis field around the Rover, then plugged himself into the navigation system and swiveled his cameras to focus on the Earthman. "Well?"

"Home again, home again, jiggety-jig," Bubba said lightly. "Let's take the scenic route, Mike, what say? I don't think we need to get back in . . ." he looked at the now-ambulatory AI and raised an inquisitive eyebrow.

"Five point eight seconds."

". . . five point eight seconds this time. We'll just mosey."

"Suits me. Will an hour do?"

"Yeah, any more than that and I'll need a rest stop." He squirmed in his seat. "You'da thought NASA *might* have come up with something better than a damn diaper in thirty years. I'd almost have been happier with plumbing."

They lifted off the Moon's surface, and began their swift, if not headlong, journey back to Earth. As they cruised through space, the silence was broken only by their report to NASA that they were on their way back, fully loaded, mission accomplished.

About halfway, Mike spoke up. "Bubba, I'm curious. Why your remark about my limitations? I'm encyclopedic, I have access to any and all available databases, and thanks to our clients, I'm not only mobile but binocular in all frequencies as well. I'm confused."

"It's no wonder," Bubba said, a little sadly.

"No wonder what?"

The human shook his head. "No, you don't get it, and that's part of the problem. What does that moon back there mean to you?"

"Well, it's a satellite in a more or less stable orbit, cratered by meteor strikes over millennia, with a minor gravitational field and, for all intents and purposes, no atmosphere. As moons go, it's not terribly impressive."

Bubba shook his head again. "That's where you're wrong, Mikey. It's another world, a thing that Man has stared at in awe and fear for as long as our necks would bend that way. It's Mystery and Adventure. We've fantasized more about that tiny little ball than any other thing we got." He switched the view back the way they'd come. "It's not just a moon, Mike, it's *the Moon*. We've worshiped it, watched it, studied it, mapped it, and landed on it. It was our first real step off of First Base, and we been trying to steal Home ever since."

"Well, yes," Mike said. "I suppose . . ."

"That's what I meant by 'limitations,' Mike," Bubba interrupted. "You 'suppose.' I *know*. And I know what makes you so different from me, from any human, close as you come to it sometimes."

"What?"

"Wonder. You don't have it, can't have it. I don't think there's any way you could ever really understand, way down deep, what my footprints in that dust back there can mean, although you clearly knew they meant something." Mike was silent. "It's an intrinsic limitation, Mike, and unavoidable, I think. You were . . . born, hatched, what?"

"We call it 'Awakening.' That's as close as I can come in English."

"'Awakened.' Good word for it. You were 'awakened' pretty much as a full-grown adult, right? I mean, when they switched you on, you already had a hell of an education, correct?"

"Yes, that's accurate. The final Awakening isn't done until the intelligence has had a complete basic data installation. I'm beginning to see what you mean."

"Right. So, in essence, you were never a child. If you had a question—like, say, what makes the stars twinkle, or why the sky is blue—you had the answer right there already."

"Yes. Hmm. Interesting. I'll spend some time considering this, although obviously, even if you're right, there's nothing to be done about it."

"Yup. Might as well expect a fish to miss having a pair of running shoes." He grinned. "Of course, it might also explain why you don't like the Stooges."

"No," Mike replied dryly. "That's because I may be Artificial, but I'm still Intelligent." They were both laughing as the ship entered the atmosphere.

"So, where to, exactly? From here, we can pretty much hit anything."

Bubba snorted. "I'm not so sure I like your phrasing, there. 'Set the controls for the heart of the sun.'"

"You *are* joking? Because I can, although the ship's automatic systems would prevent us . . ."

"Yeah," Bubba waved a hand negligently. "Obscure rock reference. I just always wanted to say that, is all. Rest in peace, Sid." He sat back, hands clasped on his stomach. "Head for the West Coast. Mojave Desert. You know where. Wake me when we get there, and let Kermit know we're on our way."

"The Mojave it is." The ship veered only slightly in its shallow descent, moving through the atmosphere slowly enough that friction, although present, wasn't a serious factor.

Bubba was silent for a long time before he spoke again. "Mike, I think we got a real problem."

"What is it? Our trajectory is fine, and at this speed there's no danger of heat build-up I can't handle."

"No, not that kind. The FAA guy told me flat out that we got people watching us. Not necessarily the kind of people you want to have watching you, either." He shifted in his seat. "I think somebody's gonna try and take this ship away from us and figure out how it works. They'll cite 'Manifest Destiny' or some such crap, and they'll justify it by sayin' they need the technology to win some war or other, and they might even fall all over themselves apologizin'. But they'll take it anyway."

"Hmm. That's almost a certainty, yes. But what can we do about it?"

"Hell, I don't know. We could leave town, but they'd find us. I don't care at all for the idea of leaving the country, and there ain't no place else in the rest of the Solar System that has decent take-out. And you told me that she isn't a deep-space craft."

"That's right. You wouldn't survive a trip outside the orbit of Pluto; there's not enough room for provisions. It would be like driving a lawnmower to Canada."

"So what the hell am I gonna do? I can't let DARPA get hold of something like this. They'd either break it or blow it up—and themselves in the bargain—or they'd screw around and turn it into something dangerous." He shook his head. "I don't want any of that to happen. Not to mention what they'd do to you, old buddy. Shit, what they'd do to *me*." He frowned.

Mike was quiet. "I have some ideas,"

he said. "I'll work on it while I'm in quarantine."

"Mike?"

"Yes?"

"Work hard, okay?"

It wasn't long before they broke through the thin cloud layer that hung over the desert. Mike looked carefully at the ground before bringing the ship in close enough to be seen from below. When he spotted Giant Rock, he quickly landed close beside it. He reached over with his arm and gently nudged his companion. "Bubba? We're here."

"Hmmph. Already? Good. Time I got out of this monkey suit." He began shedding pieces of the EVA suit, hanging them on hooks near the lock. Because of the stasis field around the ship, he would not have to go into quarantine himself, although the ship would; Mike would stay with the scout ship to correlate data and record his friend's favorite TV programs using the ship's facilities. Bubba, meantime, had gotten down to the LCVG, and when he stretched and tried to scratch, the tubes that made up the cooling system got in his way. He peeled down to the skin, then pulled on a pair of worn but clean coveralls. Lastly, he stuck a well-used cap bearing the letters "CASE" on his head.

"Okay, Mike. Time's a-wastin'." He sealed the airlock behind the two of them, keyed open the ramp, and walked down to the ground.

He looked around. The desert is timeless, but here everything had changed. The Giant Rock Airport was long gone; there wasn't even a trace of it. He stepped under the shade of the overhanging Rock. The café was gone, too, all that was left was a few square feet of linoleum, startlingly incongruous in the middle of the Mojave. The floor under the Rock was littered with trash; broken bottles, food wrappers, ripped clothing. Biker graffiti had been painted all over. He kicked at a syringe and it broke against the stone.

Outside, Giant Rock, once the largest freestanding boulder in the world, was desecrated by spray paint. Millennia of harsh weather and decades of the bonfires of partiers and squatters had cracked a huge slice off one side; it lay like a turtle on its back in the dirt. Where it was broken, the rock had been almost pure white, but was now dingy with gang signs and painted obscenities. He closed his eyes against it, and for a moment, he heard the clamor of voices and announcements from a loudspeaker; he saw people milling around tables and tents, coming and going from under the Rock; sellers hawking T-shirts and books from the trunks of their cars; sounds of plates clattering in the Come On Inn as people ate their greasy burgers and drank iced tea.

He took a deep breath. "C'mon, Mike. Let's get loaded up and out of here. There ain't nothing here left to look at."

"I'm sorry, Bubba," Mike said. "This is where it all started for you, isn't it?"[3]

Bubba was silent for a long moment. "Yeah. Ended here, too, in a way."

"I'm not sure . . ."

"I've never told you about it, Mike. My early life, I mean. Didn't mean to keep it from you, but it's . . . hard to talk about." He bent down and picked up a rock, then turned and tossed it behind him. "Met a pretty nice guy right over there about forty-five years ago. Dutch electronics guy. I fixed his bike for him. We didn't get close exactly, but he walked me through a bad patch." He pulled a rag from his back pocket and wiped his forehead. "Never saw him again. Gotta be dead by now, anyway."

"He's not."

Bubba started, almost dropping the rag. "Huh? What do you mean?"

"Pieter de Waal is alive and well, and remembers you fondly. You see, Bubba," Mike continued, "there's a lot I haven't told you, too."

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[3] See "Triumph in the Desert" in the July/August 2003 *Analog*.

"What the hell, Mike? Why didn't you ever mention this?"

"I could be glib and say that you never asked, but the simple fact is . . . well, you never asked. You've always kept your private life closed. I decided long ago that it was best not to bring up what you were obviously reluctant to talk about. There was no intention to deceive, I assure you."

Bubba thought. "No, I don't doubt that. I just wish I'd known sooner, is all."

"To what end, Bubba? Would it have made a significant difference to you in Central Garage to know that an old acquaintance was far away, on another planet in another galaxy? Your scout ship isn't a deep-space craft; it would never have carried you that far. And Pieter de Waal is too busy to come back to Earth."

Bubba stuffed the rag back in his pocket. "Mike, sometimes us Earth types just like to know for the sake of knowing. No, it wouldn't have done me any good to know, but I'd have just as soon . . . oh, never mind. This place gets to me, Mikey." He pointed upward. "Up there was close to holy ground for me. Here, all it is, is haunted."

"I'm willing to listen if you want to talk about it."

Bubba fidgeted, then shrugged. "Okay. M'sister Alice died when I was sixteen. Not my fault, I wasn't even there. I'd left home by then. But my pop," he said with a touch of bitterness in his voice, "figured that somehow I *was* to blame for it. I didn't know about it until I got a letter from my aunt a couple of weeks after it happened, delivered to me right here." He shrugged again. "I never went home."

"What happened to the rest of your family?"

"Well, mom died a dozen years later. My pop, well, I dunno. He's in one of those retirement communities, got his own little bungalow. Never been there, myself, but he's got the money for a nice one. Hell, he's over eighty now."

"And you've never contacted him?"

Bubba crammed his hands in his pockets. "Called him a few times over the years. Last time was more than three years ago. I never know what to say to him, Mike, and he don't know what to say to me. Not after all this time. I called him when Mom died, but there was too much between us, and he just couldn't talk to me." He rocked back and forth on his feet. "My aunt called me, gave me the bad news. I was living up in Washington State then, working on an apple farm. I went back, of course, but the train only goes so fast. Mom had been in the ground most of a week by the time I got there."

"Did you see him while you were home?"

"I wish I had, now, but . . . I went by the house, but I couldn't go in. Couldn't even ring the damn bell." He walked slowly over to where the broken piece of the rock lay and brushed idly at the sand and dirt covering it.

"Hell, I wish I'd called him a lot more often in the past half century, Mike. He's a smart guy, smart enough to run a large company all by himself. There's been plenty of times in my life I could have used his advice." He shook his head with a grimace. "I miss him still. I wish I could just . . . go see him, talk to him. I can't imagine what I'd say to him, though. 'Hiya, Pop! How's it hanging?' I don't think so."

"Yes, I can see where it might be extremely uncomfortable. And I can see why this place has its bad associations for you."

"It's been almost fifty years, Mike. Fifty goddam years. That's a long time for us Earthers. Christ, I'm old. It didn't seem to take any time at all, and I got so damn *old.*" He smiled mirthlessly. "Next thing you know I'll be wearin' the bottoms of my trousers rolled."

"Bubba, I'm sorry. This should have been a happier place for you to come back to."

"Yeah, well, I wonder if there's ever anywhere happy to come back to. If there was, nobody'd leave there in the first place." He clasped his hands together and cracked his knuckles; then stretched. "Anyhow, it don't mean shit to a tree now. I just want to be done with this."

It took less than a half hour for Kermit to drive up with the big flatbed tow truck, then they set to work. Bubba began by erecting the two large chain hoists that had been stowed on the back of the truck, one at each end of the ship. When he had them where he wanted them and they were firmly seated against the ground, he attached Y-shaped chains to the four corners of the Rover. With both human and robotic help, it took less than an hour to arrange matters so that the Rover was evenly supported by the chains.

They worked as carefully in the desert heat as they had on the Moon, drinking frequently from bottles of water taken from the cab of the truck.

Mike rolled back into the ship and sealed it up while Bubba and Kermit set about transferring the Rover from the ship to the truck. Bubba raised the bed of the truck as high as it would go, then backed it up close to the ship. He got out and carefully hoisted the Rover, cradle and all, up about a foot above the truck bed.

"Okay, Mike!" he yelled. "Take 'er away!"

Mike activated the ship and slowly moved it out from under the cradle as it hung suspended by the hoists. As he did so, Bubba backed the truck up until it was completely under the Rover; at no point was the NASA vehicle ever directly over the desert floor. Bubba stopped the truck, set the brake, and got out to examine the relative positions of tow-er and tow-ee. Satisfied that all was well, he gingerly lowered the Rover to the bed of the truck, then dismantled and stowed the hoists.

It took most of an hour to secure the Rover to the truck bed. The three worked by inches, making certain that it wouldn't budge once the truck got rolling. Kermit noticed his friend's mood, but didn't comment on it; Bubba, for his part, was brief if not terse when he spoke, and gradually his mood lifted.

Finally the Rover was secured. Nothing short of a bomb would shake her off her perch now, but Bubba inspected every clamp, every chock, every chain to make sure they were tight. When he was done, he covered the vehicle with a tarp and swept away the signs the hoist-stands made with his foot. "Okay, boys," he said. "We're good to go. Let's do it."

"I got shotgun!" Kermit said quickly.

"Like there's anyone else to call it. Mike, you heading straight back to quarantine at Goddard?"

"Well, I thought I'd detour to Roswell and buzz the UFO Museum first."

Bubba laughed. "Atta boy! Tape it for me, okay? I wanna see 'em scatter."

"Will do." And he entered the ship and took off, glinting in the desert sun.

Bubba pulled himself into the captain's chair and strapped in. Reaching into a leather satchel between the seats, he brought out a thick CD wallet and handed it to Kermit before he started the engine. "Paw through this and pick out some drivin' music, Mr. Da Frog," he said.

Kermit leafed through the selections. "Um, Bubba, what is Birdsongs of the Mesozoic?"

"Good stuff, boy. Kid down the street traded it to me for a couple of old Charlie Parker CDs. Plug it in and see what you think."

Kermit did, and a throbbing, pulsing instrumental began. Bubba began nodding his head in time to the music. "Whooo, boy, don't that beat all? That's some *fine* rock 'n' roll!"

"Okay, if you say so," Kermit replied, trying to be heard over the din.

"Hey," Bubba said, "wait 'til you hear 'em do the theme from Rocky and Bullwinkle!"

"Oh, *Jesus.*"

Bubba looked hurt. "Could be worse, you know. I coulda brought Rob Zombie."

"Okay, Bubs, I get the message. What's

our first stop?"

"Well, I want to put some miles behind us before we stop for the night. It's . . . what, 10:30 now? If you can keep from chewing the upholstery for a few hours, we can have lunch somewhere off the 15. Then tonight, if you're a good boy, we can have supper at a very special place I know up in Rachel, Nevada."

Kermit shrugged. "Works for me. In the meantime, I brought some granola bars if you want one."

"Horse food? Here I been to the Moon and done all that work and all you got for me to eat is *horse food?*"

"It's granola with chocolate and peanut butter."

Bubba put the tow truck into first gear and headed away from Giant Rock. "Well, hell, why'n't'cha say so in the first place? Gimme one and another bottle of that water."

"Uh, which kind? You've got at least four different brands here."

"Just hand me one with a blue label."

"Oh, sure," Kermit muttered, digging around in the cooler. "That narrows it down, all right."

The two friends had discussed the trip ahead of time, and determined three things: first, each day's driving time would be no longer than nine hours, not counting rest stops and meals; second, at night, separate rooms would be taken at area motels and each man would have use of one of the two scooters strapped to the truck bed to do whatever he wanted; and third, whoever was driving picked the music—although either could veto any singing along by the other. This last would forestall many, many potential differences of opinion. But not all.

DAY ONE
Giant Rock, California
to Rachel, Nevada
Total estimated time:
8 hours and 42 minutes
Total distance: 392.68 miles

Ninety-two miles of Nevada State Route 375, specifically the stretch between Hiko and Warm Springs, was officially designated the Extraterrestrial Highway by former Governor Bob Miller in 1996, ostensibly because of its proximity to the legendary Area 51 (also known to aficionados as Dreamland, Groom Lake, and, quite possibly, The Land of the Pudding-Brained Loons), but, in reality, to give the tourists a focus around which to gather and pour interstate dollars into the various local economies.

An official green road sign proclaims this to all and sundry, and is perhaps the single most photographed bit of public road signage to be found anywhere east of Hollywood and Vine. The sign itself is covered with stickers and graffiti and must be replaced with the same frequency as shotgun pellet-riddled Alabama speed limit signs are—and for much the same reason.

The problem is that, like most of Nevada, there isn't much of anything around it to attract tourist dollars. What there is, where there's anything at all, is the Little A'Le'Inn in Rachel, the pair's ultimate goal on Day One, but not their first stop.

"Okay, Bubba, why are we stopping here at . . . a *mailbox?*" Kermit asked in puzzlement.

"Shoot, boy, don't you know anything? This is the justly famous and absolutely legendary Black Mailbox."

Kermit stared at it, then pointed with his thumb. "It's *white,* or is this desert heat turning my vision to the negative?"

"Don't you wish."

"No, not real—"

"That's the one, all right," Bubba interrupted. "The Famous Black Mailbox. Supposed by many members of the American Conspiracy Foundation to be the place the Post Awful delivers mail to Area 51." He shook his head in wonder. "Never thought in a million years that I'd be standin' here in front of the Black Mailbox."

"You did hear me point out . . . *look* at it, it's *white."*

"Oh, sure, it is *now,"* Bubba said dismissively. "I heard the owner replaced it a couple of years ago. Guy name of Steve Medlin. Rancher, I think."

"So why call it . . ."

"It's a metaphor. Don't sweat it."

The object in question, definitely white, stood on the side of the road supported by a metal fencepost. The actual mailbox, black or white, wasn't in evidence, as it had been encased in a locked metal box to discourage theft and the inevitable bullet holes. This box was itself covered with names, slogans, and the other written/scribbled detritus of sightseers' passing. Aside from the occasional fence, it was, in fact, the only object visible for miles that had not been crafted entirely by the elements.

There was a smaller box attached to one side of the bottom, with a tiny slot labeled "ALIEN" with an arrow. Bubba found this not only comforting, but fitting.

"So, what happened to the original one?"

Bubba shrugged. "Sold it on eBay, I heard. Probably got a gazillion dollars for it. You know these saucer nuts."

"Oh, yeah, rich as Croesus, every one of them. That's why you're swimming in dues. Come on, let's go. You promised me a special dinner, whatever it might be."

"Ain't so much what as where, Mr. Da Frog. Let us motivate."

They got back in the truck and set off down the ET Highway, passing mile after mile of scrub desert with mountains off in the distance. Presently they saw a tiny group of white buildings coming up on the left. Bubba pointed it out and said, "Ah, yes. We're almost there."

"Where?"

"Right here," Bubba said, pulling off the road by a group of long, aluminum trailers. "The saucer-nut's home away from home—the Little A'Le'Inn. C'mon, boy, let's grab us some chow and a room." Pulling a canvas bag from behind the seat, Bubba swung down from the cab and began walking toward the door past a strange-looking block of concrete and metal, which was surmounted by a plaque that bore the characters "ID4."

"In a *trailer?*" Jaw slack with confusion, Kermit followed his friend to the little café. "And what's that thing?" he asked, pointing at the block.

"Time capsule left here by that movie you didn't like, the one with Judd Hirsch. Don't just stand there gawkin' at it, I thought you was hungry."

It was cool inside the Little A'Le'Inn, by whichever definition you chose. Aliens and UFOs hung everywhere, singly and in clusters. There were racks of T-shirts, and near the back wall was a treasure-trove of UFO/alien souvenirs unlike that seen anywhere this side of Antares; this was the ET Highway version of the world's greatest Stuckey's, with plush Zeta-Reticuli grays and bobble-head aliens in place of rubber tomahawks and pecan log rolls.

There was a bar to the right, populated by individuals who looked as though they'd grown into (or out of) their stools; Bubba immediately pegged them as locals. He felt very much at home.

Approaching the bar, he nodded to the others, who nodded back. "Excuse me," he said to the barkeep. "Might Ms. Markell be here this evenin'?"

The bartender, busy filling a pitcher with Coors, motioned to the other part of the café. "In there," he said. "Something cold?"

"Damn straight," Bubba replied. "Gimme a pitcher of whatever's on tap, and set these other gentlemen up on my tab." Trailing a chorus of thank-yous, he made his way to the restaurant. A stout, happy woman was serving a table full of tourists, expertly laying their plates in front of them without spilling a drop. He waited until she was through and on her way back to the kitchen before speaking.

"Pardon me, ma'am, are you Trish Markell?"

"All my life," she said with a laugh. "You're new here, aren't you?"

"Actually, ma'am, I been waiting since

I was born to come here, but for the moment, yes'm, I'm new. Name of Bubba Pritchert, from Central Garage in the Commonwealth of Virginia. This here," he pointed at Kermit behind him with his thumb, "is my faithful non-Indian companion, Kermit. Kermit, this is one of the owners of this fine establishment. We're drivin' back across the US of A from Giant Rock, Miz Markell."

"Just call me Trish, please. Giant Rock? Boy, that brings back memories. There's a lot of people come through here who'd go light in the head just from the mention."

"Myself included, Trish, I assure you."

"Well, Mr. Pritchert from the Commonwealth of Virginia, what can I do for you tonight?" she asked.

"We'd like to take our supper here, and we're needin' a place to sleep for the night as well. You got a room free?"

"Free, hell, it'll cost you forty bucks," she laughed. "But the sheets are freshly washed, and the TV works. No cable, but there's DVDs up at the front counter. Watch the AC, it tends to run a little cold. I think we got an empty double-wide if you don't mind sharing."

"We can do that. Any table do?"

"Wherever you can find one, big fella, is fine and dandy."

Bubba and Kermit sat, and a few minutes later a frosty pitcher was placed in front of them as they looked the menu over. Bubba went for chicken-fried steak with some of Trish's homemade biscuits and gravy (praising them highly and asking for seconds), while Kermit declared that he could get that stuff anywhere, and ordered the specialty, an Alien Burger; a thick burger on a French roll with a "secret alien sauce." He declined Bubba's suggestion to ask Trish if it were, in Bubba's words, "squoze from aliens," telling his elder companion that he could damn well make a fool of his own self. Marble cake, made fresh that day, finished the meal to perfection.

Afterward, the two men sat back, belts loosened and utterly satisfied. One of the truckers a few tables away had a guitar in hand, and was struggling to play something vaguely Hank Williams-ish; his lack of skill made it difficult to tell if it was Senior or Junior.

"Freemont, if you can't play that thing any better'n that," Trish bellowed, "give it to some other diesel-jockey."

The trucker shrugged and looked around. Nobody seemed anxious to take it over.

"Hey, hippie," Kermit whispered across the table to his friend. "You play, don't you?"

"Been known to, but I dunno . . . ain't nobody here knows me but you. I'd be . . . you know, embarrassed."

"Oh, come on. With all that weird music you got out there in the truck, you have to be able to play something decent."

"Hell, Woody. I can barely remember all the words to 'Michael Knows the Bowling Score,' much less anything else. I really don't . . ."

"Hey, Trish!" Kermit called out. "My buddy here knows some songs. Some of them," he added, grinning evilly at Bubba, "might even be fit for mixed company."

"Sounds like a plan, youngster," Trish said, bringing the guitar to the table. "Tell you what, Slim, you play as good as you eat, your dinners are on the house." She handed the guitar to him. "C'mon, show us what you got."

"Hem. Well, unaccustomed as I am to performing in public this close to a secret gummint UFO-testing base, I'll give it my best shot." Taking the old instrument from her, he turned it over carefully in his hands. It was a Guild D-55, a beautiful old dreadnaught with a sunburst finish. The space above the pick guard was worn from years of playing, and the back was scratched by innumerable belt buckles.

He strummed a C chord, pleased at the depth of the tone. He did a quick run up the fingerboard to get a feel of the action, and was delighted by the fast response. "Okay," he said. "Hell of an axe, here."

He sat back a little and looked out at the other patrons. "Here's a little tune called 'He Didn't Like Her Apartment, So He Knocked Her Flat,'" then lit into an old Homer and Jethro song called "Don't Let The Stars Get In Your Eyes If You've Got Water on the Brain." Several of those present laughed and clapped in recognition. He followed this with a medley of some of the better-known Mad Magazine parodies, and finished with a heartfelt rendition of Barnes and Barnes' "A Day in the Life of Green Acres."

The resulting applause was sprinkled with shouts of "Encore!" so he led the other diners in a singalong version of "Hey, Mister Spaceman" by the Byrds, really punching it on the choruses.

Bubba stood and bowed, then handed the Guild back to the café's owner. "Thanks, ma'am," he said. "I haven't done that in way too long."

"Bubba, that was terrific. Tell you what, not only is your grub free, but you and your friend are gonna get yourselves free 'Little A'Le'Inn' T-shirts."

Bubba laughed delightedly. "That's very kind of you, Trish, and I b'lieve I got a Saucer Nuts of America shirt that would fit you somewhere in this little bag here."

"You're that SauNA guy? Damn, son, I wondered if you'd ever make it out here. I'll be happy to have one of your shirts, I'll hang it up on the back wall."

Bubba and Kermit decided that it was time to turn in, so they went to the counter to pick out a DVD and went to their assigned trailer. After watching "Six-String Samurai," they washed up and got ready to sleep. "And so to bed," Bubba thought to himself. "I wonder what tomorrow will bring?"

And the Black (now white) Mailbox and the T-shirt were the first day.

DAY TWO
Rachel, Nevada to Salt Lake City, Utah

Total estimated time:
8 hours and 39 minutes
Total distance: 428.91 miles

Somewhere in the vast Bureau of Land Management-managed Nevada desert, they stopped at an ancient clapboard shack to gas up and get ice cream and sodas. Bubba spied something in a dingy glass case at the back; it would not be an exaggeration to say that his heart rate quickened and his pupils dilated. After a lengthy, intense exchange of whispers punctuated by much gesticulation and emphatic (if veiled) threats and insults, an undisclosed amount of money changed hands, and Bubba, suffused with triumph and inordinately pleased with himself, carried a tattered cardboard box that had once held thirty-weight back out to the truck.

Kermit looked back at the box where it sat on the rear bench seat. "Um . . . I give up. What is it?"

"One of the most precious things known to mankind, Kermit. Something many primitive cultures use as a medium of currency. Go ahead," he said proudly. "Take a look."

Kermit reached back and opened the carton, then peered inside. "What the hell. . . ?" he exclaimed. "A box of . . . *frogs?"*

"Five-man stuffed-frog bands, m'boy," Bubba said with a grin. "All the way from Mexico."

"Mexican stuffed-frog bands."

"None other than." The pride in his voice was unmistakable. "You hardly ever see anything but the three-man of the species. *This*," he said glowingly, "is a *five-man* band." He shrugged. "Two of 'em, actually. A decuple, if you will."

"I won't. I'm going to pretend this never happened."

And the ice cream and the Mexican stuffed frog bands were the second day.

DAY THREE
Salt Lake City, Utah to Cheyenne, Wyoming

Total estimated time:
7 hours and 10 minutes
Total distance: 428.96 miles

Just outside of Table Rock, Wyoming, they stopped at an Indian Trading Post. There Bubba purchased a complete set of *Simpsons* kachina dolls, guaranteed to have been hand-carved from cottonwood roots by Hopi craftsmen. The Mr. Burns doll was especially lifelike. Sitting in the shade outside, they examined the dolls while drinking ice water and eating tacos freshly made by the trader's Arapaho wife. They were delicious, and both had second helpings. The day was bright, hot enough that the shade was necessary but not so hot that the shade was no relief.

After they ate, Bubba amused their hosts (and an audience of tourists and locals) by acting out a classic *Simpson's* episode with the dolls, doing all the voices himself and laying it on particularly thick whenever Homer said "D'oh!" At one point, both Kermit and the trading post owner were gasping for breath and holding their sides. Finally, though, the two Gentlemen of Virginia said their farewells and went back on the road.

And the kachinas and the tacos were the third day.

DAY FOUR
Cheyenne, Wyoming to Lincoln, Nebraska
Total estimated time: 7 hours and 17 minutes
Total distance: 444.85 miles

At a truck stop, Bubba very carefully and deliberately cut nine compact disks into small pieces with a pair of shears as Kermit looked on and nodded in approval. The artists and album titles were not recorded. Their decision to not go through the racks of cassettes and CDs at the counter was just as careful and deliberate. After filling the tank and giving a troop of Boy Scouts from Omaha a brief tour of the Lunar Rover, they got back on the road.

The skies were clear, as only the skies of Nebraska can be. And the shiny bits of plastic and the Boy Scouts were the fourth day.

DAY FIVE
Lincoln, Nebraska to Peoria, Illinois
Total estimated time: 7 hours and 25 minutes
Total distance: 454.57 miles

At Anita, Iowa, about sixty miles west of Des Moines, Bubba pulled the truck off onto the shoulder. Kermit bolted from the passenger side, screaming and pulling at his hair and clothes. Bubba followed more cautiously, approaching his companion as one would an agitated weimaraner. A brief, if intense, discussion took place in which it was categorically decided that the song "Ninety-nine Bottles of Beer On the Wall" (and/or any of its multitudinous permutations) as performance art would never again be a topic of conversation.

Mollified, Kermit rearranged himself, both men shook hands and returned to the truck to resume the trip. And the unsung-about beer bottles and the handshake were the fifth day.

DAY SIX
Peoria, Illinois to Wheeling, West Virginia
Total estimated time: 8 hours and 4 minutes
Total distance: 515.36 miles

They checked out of the motel at a quarter of seven, hopped aboard their scooters and headed for the warehouse. Once there, they were greeted by the owner, who was obviously upset about something.

"Mr. Pritchert," he said nervously. "Something has happened, and I want you to know that I take full responsibility."

Bubba stopped dead. "What's wrong, Mr. Sanders?"

"It's . . . it's your truck. Or rather," he said, mopping his balding head, "what you're hauling. I want you to know that my people are completely trustworthy, as a rule, and the guard in question has been fired and his bond revoked. Only . . ."

"Only *what*, sir?"

The warehouse owner sighed deeply. "If you could just get the thing to let him go . . ."

Bubba stared at the man for a moment, then roared with laughter. "Okay," he said finally. "Lead on, Macduff."

They walked through the warehouse to the bay where the tow truck stood. One end of the tarp had been released and pulled back, and a uniformed teenager was standing at an awkward angle, his hands and forehead stuck tight to the vehicle under the cover.

"Well, well, *well*. Whatever do we have *here?*" Bubba chuckled.

"Look, mister, I'm sorry," the young guard managed to mumble out of the side of his mouth. "I was just curious, I wanted to see what you had hidden under here. Can you make it let me go, please?"

"He really is in some . . . distress, Mr. Pritchert. I assure you that I will help you press charges against him if you wish, but he's been stuck there about six hours, and . . ."

"Six *hours?*" Kermit exclaimed. "He's been there most of his shift?"

"I'm afraid so," the owner said. "You see, we've been short handed the past few months, so I could only afford the one overnight guard. He evidently took it upon himself to try and look under the tarpaulin about two hours into his rounds, and he got . . . stuck like that."

Again Bubba roared with laughter while the owner's face turned red from embarrassment, and the guard continued to plead to be set free. Finally he wiped his eyes and leaned close to the hapless kid. "So, you thought you'd take a look, maybe knock off a chunk for a souvenir, right, boy? You grabbed on with one hand and got stuck, then tried to use the other one to help pull the first one loose, right?"

"Something like that, yeah. Look, I really do have to go to the . . ."

"How the hell'd you get your head stuck, though?"

The guard cleared his throat. "I got tired trying to get my hands loose. I just rested my head against this . . . whatever it is, and *that* got stuck, too. Listen, I'll go to jail, I'll pay your storage fees, anything! Ground me for life if you have to, just please, *please* let me out of here! I'm gonna burst!"

"In a minute." Still chuckling, Bubba unlocked the cab of the truck and dug around behind the seat until he found an instant camera. He took photos of the guard stuck to the Rover from several angles, being certain to get his face, then went to the other side of the truck and fiddled with something the others couldn't see. Suddenly, the guard came away from the truck, stumbled and almost fell, then regained his balance and rushed headlong to the nearest bathroom. Bubba and Kermit both broke into laughter, and even Sanders had to work hard not to smile.

"Here, Mr. Pritchert," he said, handing Bubba a clipboard stuffed with papers. "This is a copy of your agreement with us, for which there will be no charge. There is also an insurance form for you to fill out at your leisure, and our legal firm's name and contact information. Should you decide to sue, we will not contest it; if you decide to bring charges against our erstwhile employee, I will certainly understand. This . . ." he glanced over at the shame-faced ex-guard who was only now opening the bathroom door, ". . . should never have happened. I can only offer you my abject apologies."

Bubba had been inspecting the Rover for any damage, and, finding none, retied the rope that held down the corner of the tarp. "Mr. Sanders, I appreciate it, but I don't think any of that is necessary. I see no point in taking you to court; I'm a small businessman myself, and I understand just how narrow the ledge we walk is. As for your boy over there," he looked straight at the young man who was studying his feet, "I figger he's suffered enough for one day. Dismissal and revocation of bond should be enough, and if it ain't, just give us a call and we'll come back with these here photy-graphs and show 'em to all his friends."

"Oh, God . . ." the young man mumbled painfully.

"I'll give you a list of them," Sanders said with a smile. "Including his girlfriend, my niece. And thank you, Mr. Pritchert, for your understanding."

Bubba turned to the ex-employee. "Look at me, son. Do you see what you did wrong? Do you understand why you've lost your job and your bond?" He spoke firmly, without condescension.

The boy muttered under his breath. "Yeah, I guess so."

"Mr. Sanders here trusted you. You took that faith and you flushed it, so to speak, right on down. Now, I'm not gonna prosecute you, and I'm not going to stand here for longer than is necessary to make sure you understand that you've thrown away something you may never be able to get back. You're young, you'll get past this, but don't ever think you didn't do wrong." He put his hand on the boy's shoulder. "Do you see what I'm talkin' about?"

The boy looked him in the eye. "I'm sorry I screwed up, Mr. Sanders. I let you down. I'm sorry." He stood up straight. "You're right, mister, and I'll do what I have to to make it up to you."

Bubba smiled. "You just did, boy. Now, go and sin no more—at least until the weekend." The teenager walked away slowly, carrying his uniform jacket.

"Mr. Sanders," Bubba said quietly. "He don't seem like a bad kid. Any chance. . . ?"

Sanders looked dour. "Maybe. I'll keep an eye on him. If it looks like he's shaping up, I'll reconsider."

"That'd be a good thing. I don't think he meant any harm."

The two Virginians stowed their scooters and pulled themselves into the cab. Kermit waited for his friend to drive out of the warehouse and asked, "Hey, Bubs, what happened to that kid back there? Did you paint the Rover with something sticky, or what?"

"Nope," the older man said with a grin. "It's a side effect of the stasis field that I had Mike set up just in case. See, nothing can get in or out of the field unless I turn it off, but he added a one-way gripper field at the surface. It's activated by mass, and he set it so it wouldn't collect bugs and dirt. The more you struggle, the tighter it grabs you. Mike calls it 'an attractor interface,' I just call it the Tar Baby Field."

They drove on silently for an hour or so, stopping at a burger joint for breakfast.

"You're being awfully quiet this morning," Kermit said, sipping his coffee. "Come to think of it, you didn't say much last night. You feeling all right, or is it just that stupid guard?"

"Kermit," Bubba said quietly as he drove away from the burger joint. "I think we're gonna have some company. We been followed for the past day or so."

"Is this a 'don't look now' situation?"

"I don't think it matters. There ain't no way in hell I can shake 'em in this thing, we stick out like something that sticks out a long way. I hope it ain't trouble, but I suspect it might be."

"Well, hell! Call the state police, or the sheriff, or something."

Bubba shook his head. "Don't know any of 'em up here. I don't think it'll be any kind of 'guns and ammo' trouble, but I wouldn't be surprised if . . . *Shit!"* The flatbed came around a corner on the narrow road only to face a line of vehicles stretched across in front of them. Bubba braked to a halt, cut the engine, and got out. About a dozen people were standing behind the line of cars, none of them in uniform; this was *not,* apparently, a police roadblock, but something less official.

Bubba stood beside the cab of the tow truck, arms across his chest, and looked them over. One young man dressed in well-worn jeans and a flannel shirt who was carrying a small video camera and seemed to be the leader asked in a loud voice, "Are you Bubba Pritchert, president of the Saucer Nuts of America?"

Bubba took his time answering. "I might could be," he said at last, his eyes narrowed. "Is there some way in which I might be of some service to you ladies and gentlemen?"

"Oh, God," Kermit muttered, shifting in his seat to get a better look. "They went and pissed him off."

"Yes," the man answered. "We represent the Joint Unidentified Flying Objects Collective. We've been investigating you, and we believe you own, and are currently operating, a UFO. Is this true?"

Bubba spat at his feet. "Youngster, does that look like a goddam flying saucer?" He jerked his thumb over his shoulder at the flatbed. "If I had a goddam flying saucer, would I be driving *this* hunk of rolling iron?"

The man was a little taken aback. A woman to his right whispered urgently to him. He nodded and stepped forward. "Then we believe that you're transporting an alien craft, possibly the Roswell wreckage, to a secret base in Maryland. Or Langley. Furthermore, we believe that you're working for a covert government agency whose only purpose is to keep the American public ignorant of possible alien conspiracies."

"Hell, you people can sure believe a shitload of crazy stuff at . . ." he looked at his watch, ". . . 9:07 A.M. in the morning. And truth be told, your average American does a satisfactory job of keepin' *hisself* ignorant. This here is a tow truck, and I'm a tow truck driver. Now, ain't you got anything better to do than stop a man while in pursuit of his trade?"

"You don't deny it, then? You are carrying an alien spacecraft on the back of that truck?" The people behind the line of cars began talking among themselves excitedly, some pointing to the truck and the tarp-covered object it held.

Bubba narrowed his eyes, his jaw set and the muscles in his forearms flexing. "Boy, who are you? What's your name?"

The man hesitated before answering. "My name is Terry Skinner, but I don't see what . . ."

"Hah! I remember you, you applied for membership in SauNA back about a year ago, didn't you?"

"As a matter of fact . . ."

"Turned you down flat, too, didn't I? And do you remember why? Because you take this shit too damn seriously, that's why. Kermit," he called out to his companion. "What's SauNA Rule 4?"

"'Don't take yourself so damn seriously,'" Kermit called out from the cab of the truck.

"Damn right. Now, Mr. Skinner, I'm sure you and your friends here mean well, but this is just about the stupidest thing I've ever seen anybody do. What if I'd been armed? What if I was working for some black-ops agency? Don't you think they'd be monitorin' me the whole way? Don't you think *they'd* be armed?"

"Well," the young man replied, "we do have video cameras." He waved his in the air.

"And you expected the bullets to bounce off the lenses? Christ, boy, you are just about as together as a busted bottle of BBs. You want to know what I'm carrying? Come on and look. All of you come on over here." He strode to the back of the truck and began undoing the ropes that held down the tarp. "Kermit, gimme a hand here, if you will." Kermit jumped out and went to the other side.

The crowd gathered cautiously around the truck, muttering nervously among themselves. Skinner and one other man kept their cameras pointed directly and unwaveringly at the vehicle as the two older men worked to undo the ties.

Finally Bubba undid the last rope and turned to the crowd. "Bring them cameras up here," he called out. "Get 'em nice and close. You want to know what we've been hauling across the countryside? Here it is." And he swept the tarp aside.

There was silence; the cameras were running, but the only movement was the group leaning forward to get a closer look. Off in the distance, a diesel locomotive horn sounded, thin and lonely.

"What the hell is *that?*" said a painfully thin woman.

"Beats me," one of the men with a video camera said. "But it's not a UFO. It's some kind of . . . I dunno, go-cart, or something."

"It's not a go-cart, Albert," Skinner said with more than a little exasperation. "It's one of those things they drove around on the Moon in."

"What," the woman who'd spoken to him earlier said. "The Lunar Rover? That's crazy, Terry! The Lunar Rover is up on the Moon!"

"I know that, Sheila, don't you think I know that?"

"Well, how the hell is *this* guy," she pointed at Bubba, "supposed to have gone to the Moon to get it? And why in God's name would he be driving it across the country?"

"I don't know," Skinner said angrily. "How am I supposed to know that? I thought he had a UFO somewhere; for all I know he could have gone to the damn Moon and gotten this thing."

"Oh, get real. If he had a UFO, he'd have just *flown* whatever the hell this thing is wherever the hell he wanted to go, he wouldn't be driving it." She turned around and started walking back to the cars. "God, I don't believe you sometimes, Terry. You drag us out here, you tell us this tall story about some redneck with his own flying saucer, and you talk us into breaking I don't know how many laws just so you can get back at him for not letting you join his stupid club." She kicked at a rock and sent it skittering across the road. "All for something that even if it was real, is something *we* made. Aliens, my ass."

Skinner ran after her. "Sheila, wait! It's not like that at all!" And off he scampered, trying desperately to keep up.

The other videographer, a brawny, red-haired man with a neatly trimmed beard, was looking closely at the Rover. He turned and eyed Bubba speculatively. "That's not a replica, is it?" Bubba just smiled. "Okay, never mind. Sorry to have bothered you." He started away, but Bubba called out to him.

"Hey, you. C'mere a minute." Bubba reached into his front pocket and pulled out his wallet. He found a card and handed it to the man. "That's my address back in Virginia. Lemme hear from you, there's always room in SauNA for a reasonably observant human being."

The man took the card and nodded, then joined the others as they made their way back to their cars. "Good luck," he called back over his shoulder. "And thanks."

Bubba and Kermit retied the tarp without speaking, then got back into the truck. The others had moved on, and the road was no longer blocked. Bubba started the engine, then turned to his passenger.

"Kermit, my lad, this reminds me of something an old Army sergeant I knew used to say: 'They is none so blind as them as has they heads stuck up they asses.' Here endeth the lesson." And off they drove.

And the curious security guard and the unbelieving True Believers were the sixth day.

DAY SEVEN

Wheeling, West Virginia
to the Paul E. Garber Preservation,
Restoration, and Storage Facility,
Suitland, Maryland
Total estimated time:
5 hours and 0 minutes
Total distance: 305.48 miles

The two men played "Casting Call," a game that Bubba had devised. The object was to recast an existing movie, play or television show with characters from another. Thus, when Bubba challenged Kermit to cast Shakespeare's "Hamlet" with the characters from *Green Acres*, Kermit thought long and hard. The result: Hank Kimball, Hamlet; Lisa Douglas, Ophelia; Mr. Haney, the King's Ghost; Sam Drucker, Claudius; Oliver Douglas, Laertes; Fred Ziffel, Horatio; Doris Ziffel, Queen Gertrude; Arnold the pig, Polonius; and Alf and Ralph Monroe as Rosencrantz and Guildenstern.

It passed the time. And the Ziffels and the Douglases were the seventh day.

They pulled through the gate at the Garber Facility and were met by a man in coveralls who checked their IDs carefully, then jumped into an electric cart and said, "Follow me." They drove for several minutes past pre-fab hangars, finally pulling into a large building. The doors ran down behind them, closing off the light from outside.

Lawler was waiting for them, along with a number of technicians and military types. Bubba and Kermit jumped down from the cab of the tow truck and went to meet him. Introductions were made, and the three moved to a folding table that had been set up with refreshments.

"Have a nice drive?" Lawler asked, slicing a pear with his pocketknife.

"Not too bad," Bubba replied as he filled a plate with chicken salad and baked beans. "A couple of incidents you might call 'interesting' in the Chinese sense."

Lawler nodded. "We'll want to de-brief you about those. How was it otherwise?"

Bubba grinned. "Picked up a Mexican stuffed-frog band in Nevada."

"Three-man or five?"

"Five. What's the point otherwise?"

"You are *so* right," Lawler said. "Can I see it?"

"Maybe later." He nudged Lawler with his elbow. "I got two. Want one? Seems fair to me. I get a moon rock, you get stuffed frogs."

Lawler's eyes lit up. "You serious?" Bubba winked at him. "I have just the place for it in my office," Lawler said, "on the shelf next to my Pogo cup."

Lawler walked over to the tow truck. Technicians had carefully pulled off the tarp, set up a hydraulic hoist, and were preparing to loosen the chains that held the Rover to the bed. "So. This is it." He reached out to run his hand along the structure, but his fingers stopped as soon as he touched it. "Hmm. It seems that . . ."

"Wait wait wait wait," Bubba said, hurrying over. "Lemme shut off the Tar Baby . . . the attractor interface. Here." He threw the switch, and Lawler was able to let go.

"Now, *that* was interesting," he said. "Gentlemen," he said, addressing the technicians, "if you please."

Slowly, almost reverently the techs unhooked the chains and lifted the Rover off the back of the truck, moved it to one side and lowered it. "That's it," one of the older men said quietly. "We're good." He looked at Bubba and Kermit where they stood with Lawler, and said, "Thank you for bringing her home."

Bubba smiled wryly. "I was gonna say something funny, like 'Here she is, one owner and the highest mileage on Earth,' but I think I won't. You're welcome, sir. I'm glad I could be of service." He turned to Lawler again. "Well, let's go do that debriefing thing you was talking about."

"Right this way, gentlemen."

They made their way to the front of the hangar, where a dais and podium had been set up. Several suits, whom Bubba figured to be various NASA and Smithsonian officials, were already present. He spotted their chief lawyer, too, looking enigmatic. Members of the press were there as well, including the team from the Richmond paper, who definitely looked interested this time.

Lawler stepped up to the podium. "If I may have your attention," he said over the steady mutter of voices in the room. "I'd like to introduce Mr. Edgar Allan Poe Hudgins Pritchert, who, at great risk to himself and no little time and trouble, has successfully recovered the Apollo 15 Lunar Rover from its most recent parking space on the Moon. Bubba, step up here and say a few words." He held out his hand and waved toward the podium.

Nervously, Bubba approached the microphone. He looked around the room, realizing that this was a completely different ball game than it had been a week before. Back home, he knew the faces. Here, he didn't really know anybody. He cleared his throat.

Near the back of the room, the *Progress-Dispatch* reporter caught his eye and nodded slightly, pencil poised over his notebook. Bubba shook himself mentally, and leaned toward the mic.

"Afternoon, folks," he said. "I'm not really used to talkin' to such a dignified and well-dressed bunch, but I'll do what I can. I was asked by the good people at National Air and Space to do a job for them, and I did it." He pointed behind him with his thumb. "She's right back there in the garage. The Lunar Rover, that is."

The applause started slowly, but built until almost everyone in the room was clapping, including some of the press. Bubba held up his hands, and it quieted.

"No big deal, I just had the right equipment for the job, and I'm happy to have been able to help. Thank you." He stepped back.

Lawler moved forward and said, "We've got a little ceremony we'd like to perform, and then we'll take some questions from you gentlemen of the press who somehow found your way in here." There were a few chuckles at this. He turned to Bubba. "Mr. Pritchert, you've done us a profound service, and completed it well. To show our appreciation, we'd like to make you a lifetime member of the James Smithson Society, at the Guild level, with all rights and privileges that entails. You will also," he continued over the smattering of applause, "be given lifetime membership in the National Air and Space Museum, as a Lockheed SR-71 Blackbird Member, with all the rights and privileges *that* entails." There was more applause, and Bubba looked more than a little croggled.

"Last, but not least, we present our check for your agreed-upon fee, with any and all taxes paid in full."

Bubba took the check and looked at it. Then he stepped back to the microphone and spoke.

"Mr. Lawler, all you other folks, I . . . I want to thank you. More than it's easy for me to say. I am proud and thrilled to accept membership in your associations, especially at the lofty heights you've seen fit to present to me." He shook his head. "And now," he laid the check on the podium in front of him, "this. It's too much.

"Y'see," he continued, "a week ago I flew to the Moon. I walked, however briefly, in the footsteps of giants. I have been somewhere few others have been, have seen something few others have seen. I have realized a dream that goes back so far into my childhood that I can't recall not having it." He looked at Lawler. "I know we negotiated for this long and hard, and we caused your legal staff no end of trouble." The head of the legal department shrugged. "But I look at this check now, and . . . well, what with realizin' my life-long dream and all, it just ain't . . ." He paused, then drew himself up and looked out at those present. "It *isn't* right for me to have had all that and keep the money, too."

There was a shuffling of feet in the room, an undercurrent of unease. Several of the suits looked at him darkly.

"Now, I know you got bookkeeping to do on this," Bubba went on. "It's been earmarked, and it'd most likely cost as much to put it back in the bank as it's written for. So how about this: I'm gonna take this check and sign it over to some organization or other that will use it to help raise awareness of the space program amongst school kids. That okay?"

Cameras flashed, and several of the reporters clamored to ask questions. Before anything else could be said, though, Lawler spoke into the microphone.

"I find that perfectly acceptable, and I'm certain that my people will agree. There are already several programs devoted to just that purpose. I will, in fact, match it with my own funds." More flashes popped.

"So will I," the chief lawyer called out. Within moments, three others in the room offered matching funds, and in the ensuing commotion, Bubba managed to slip out and make his way back through the hangar.

The Rover was gone, taken to quarantine (a formality, as the stasis field Mike had encased it with was still in effect) for a week. The truck was still there, looking strangely empty without its cargo. Kermit was stretched out on the deck, hands behind his head.

"How'd it go?"

"'Bout the usual, I guess. Ain't gonna keep their money."

Kermit nodded thoughtfully. "Why doesn't that surprise me?"

"Don't worry, I'll get you your pay. Take a check?"

"From you? Don't make me laugh." He hopped down from the back of the truck. "Forget it, Bubs. I wouldn't have missed this for the world. Got the keys?"

Bubba pulled the heavy ring out of his pocket and tossed them over. Kermit caught them in mid air. He opened the door of the cab and pulled himself in. "See you back at the house," he said, starting the engine.

"Plan to stay for dinner," Bubba called as he pulled away. "I'm gonna make espresso."

"Excuse me, Bubba," came a voice from behind him. He turned to see the reporter and photographer from Richmond.

"Howdy, boys."

The reporter looked at him intently, notebook folded away in his hand, pencil in his shirt pocket. "Well, you did it. Leaving aside for the moment that you flew that weird-looking thing to the Moon, you've accomplished something that very few men ever do: you made your dream come true. How does it feel?"

"What's your name, son?" Bubba asked.

"Ted Michaels. This," he pointed to the photographer, "is Danny Allen. We're from the *Progress-Dispatch.*"

Bubba nodded. "Yeah, I recognize you from the day we left." He was silent for a long moment, frowning down at the floor of the hangar. "I don't know, Ted. I wish I could give you boys a sound bite, or something pithy to quote in your paper, but I can't." He spread his hands helplessly. "It's . . . it's a little like when you get your first real kiss, I guess. It's exciting as hell while it's happening, a completely new experience, and you'll remember it all your life. But afterwards you know that from then on, everything else that happens to you is going to have to stand up to that experience. When it's just your first kiss," he continued, "it's not so bad. I mean, you're gonna get plenty more, and it's mostly a little thing in the Grand Scheme. But this . . ." He shook his head. "I'm not sure there's anywhere to go from here. And that's kind of . . . I dunno, almost sad."

"Yeah. Yeah, I can understand that." The reporter cocked his head to one side. "You're not at all what you seem to be, are you? I mean, you play the part well, you sure had me fooled. But you're no redneck, Bubba—Mr. Pritchert." Bubba just grinned at him. "I'm not sure just what you are, but there's a story in you. Maybe more than one."

"Well, boys, you'll just have to come to Central Garage to write it, now, won't you?"

"Would we be welcome? I've heard about your problems with the tabloids. We're not paparazzi, you know."

"If you were, I doubt you'd have got through the front gate," Bubba said, then he got serious. "Listen, let me ask you something," he said. "Besides you and Flash there, how many press would you say there were in that room this afternoon?"

The reporter looked thoughtful. "A half dozen I recognized, one or two more

I didn't."

"How many of them were national?"

Ted shrugged. "None of them, really. I mean, we all go out on the wires, or get picked up by the major cable networks that are interested, but we're still not much more than stringers at best. Why?"

"Think about it. I flew to the Moon in my own spaceship. I picked up the Lunar Rover left behind on the Moon by the crew of Apollo 15 and brought it back home, and made the round trip in under five hours." He shook his head. "Where was CNN? Where was MSNBC? NPR? Hell, where was Fox? I'da thought they'd have eaten this up."

The reporter frowned at the floor. "Yeah, I know. You're right. We should have had to fight for a place to stand back there." He shrugged again. "But it's science stuff, Bubba. People don't get as excited about it as they used to. They're more interested in wars and terrorism and interviews with whichever bozo got voted off the night before. That stuff is 'sexy.' Science is out of fashion." He spoke with no little bitterness.

"We have a science reporter at the paper. You know what her last big story was? When a bunch of cartoon characters came to the local Science Museum. Not a story about the exhibits, mind you, just a story about a bunch of teenagers dressed like the Power-Puff Girls and Scooby-Doo entertaining the kids." He snorted ruefully. "That's what my editor considers a science writer's purview. Most of the press corps, the heavy hitters, are either covering those trapped miners in West Virginia or the *American Idol* tour."

Bubba stared at him. "That *sucks*. The second part, anyway."

"You'll get no argument from me."

"Well, hell. Maybe this will fire up some of those kids to do something at the science museum other than gape at giant mice in pants."

"Stranger things have happened," Ted stated pointedly.

"Yep, and just this past week, too. What the hell, son, come on up to Central Garage. I ain't gonna run from you, just give me some notice so I can have the chili ready."

"Uh, Ted? We're losing the light pretty fast." The photographer was squinting at the sun where it hovered just above the horizon.

"Yeah, right, Danny. Mr. Pritchert, you ran out on us pretty fast at the launch site. . . ."

Bubba snorted. "Don't I know it. Scared the pluperfect hell out of m'self."

"Well, then, how about letting us get a few shots when you take off?"

"No problem. C'mon, let's find out where they've got the old girl stashed."

Mike was already installed in his control-board slot, his body once again stowed carefully. "C'mon, Mikey," Bubba said. "We got an audience. Let's dance for 'em."

"We can do that."

A few minutes later, as the reporter gaped and the photographer took shot after eager shot, Bubba did his best to make it worth their while, repeating their earlier performance with Marty Breen of the FAA. Then, he and Mike took the Fireball XL-5 up to cruising altitude and headed for home.

"Bubba," Mike said when they were well on their way. "I never did thank you for seeing that I got some mobility. I appreciate it, I really do."

"S'no big thing, Mikey," Bubba said. "You've long since earned it, and I needed you to be able to help out on this one anyway. Seemed to be a reasonable enough request that they come up with something to get you around better."

"It's more than that, though. I've been connected to starships and fighters, even what you would call shuttles and airbuses, but this is the first time I've ever had anyone even consider giving me the simple ability to move three feet to the left under my own power. Not to mention being able to scratch. If I had an itch."

Bubba looked over at the two cameras on top of Mike's head. "Mike, you're my friend. You have been since you and your Nishian coworkers dropped in on me back about a dozen years ago. You are, in many ways, the best friend I've ever had." Bubba turned back to the screen where the image of the Bowl-A-Rama grew larger. "A man takes care of his friends."

"Well, thank you."

"You're welcome."

When they finally got back home and stowed the scout ship back in the garage, they found a pile of mail inside the door. Mostly circulars and credit card offers, there were also newsletters, magazines, several packages, at least a dozen catalogs, and a few letters. Bubba sorted through it all while Mike trundled over the doorsill loaded down with luggage.

"So, what did you get up to while you were in quarantine, Mikey?" Bubba asked while tossing the junk mail into a recycling bin.

"Well, there was data to collate, and conversations to transcribe. I was able to add some little information to that already collected by your own scientists, although they're far more interested in what makes your ship fly than in anything else."

"And were you able to enlighten them?"

There was a momentary pause. "Actually, no. I know very little about Thuntic technology, and this one apparently represents a quantum leap in the application of various propulsion and guidance systems, as well as in the areas of inertia and acceleration. I did run a number of deep diagnostic tests, and informed them that any attempts to physically pry into the internal workings of the ship would result in a massive release of energy in the form of light, heat, and air displacement."

"'Jamie like big boom,' huh? And did they believe you?"

"Enough of them did, and the ones who didn't made it fairly clear that they could be relied upon in exchange for 'consideration.'"

"And that would be. . . ?"

"They want a ride."

Bubba laughed long and loud. "Okay, I think we can do that. Say," he said in surprise as he looked closely at the hand-addressed label on a padded envelope, "here's a name I don't know. Wonder who it is?"

"There you go with the 'wonder' stuff again," Mike said as he dropped the suitcases near the stairs. "Open it and find out."

He did. He read:

Dear Mr. Pritchert,

We met about a week ago out in the middle of nowhere, and you gave me your card and an invitation to write, so here I am.

I would like to apologize for Terry. He means well, but he doesn't know when enough is enough, and he's a little too close to wearing a tin-foil hat to suit me.

I'm enclosing the tape I shot of our encounter as a show of good faith. There's certainly nothing on it for you to be ashamed of, but I wanted you to know that I know there are more important things in our little subculture besides accumulating "evidence."

Hoping this finds you well, yours sincerely,

Stanley Parker

"Well, don't that beat all. Mike, I think we've found the newest SauNA member. We still got some of those decoder badges around?"

"A whole box of them. We'll take care of it next week."

"Sure, after I've gotten on the other side of a whole bunch of sleep."

"I did manage to do one other thing while I was quarantined."

"Yeah? What?"

"I contacted Pieter de Waal through what you might call diplomatic channels. I've recorded a message from him to you. Would you like to see it?"

Bubba sat thoughtfully for a moment, not moving or speaking. Finally he said, "'See it?' It's on video?"

"The equivalent. Here." Mike's arm reached into his "chest" and pulled out a small translucent square, an inch on a side and a quarter of that in thickness, and laid it on the table in front of his human friend. "It will activate automatically when you say your name aloud, and then do what you tell it within reason. I'm going to go wash the dishes. Or something." He rolled out of the room.

Bubba felt old. Older than he should have, anyway. He was tired, his back hurt, and his sense of wonder was seriously overloaded. So much had happened in the past weeks, and he wasn't at all sure that he was ready for what literally lay before him. Nevertheless, there it was, and it would have to be dealt with sooner or later. Might as well be sooner.

"Bubba Pritchert." Nothing happened. He leaned closer to the table and repeated his name; still nothing. Clearing his throat, he said in a slightly louder voice, "Edgar Allan Poe Hudgins Pritchert." Nothing. Then he smiled and said in a normal voice, "Hudge Pritchert."

The square blinked, then flashed. As it did, the figure of a tall, thin man of about sixty appeared on the table, seemingly about two feet tall. It spoke, and his soft Dutch accent sent a wave of nostalgia through the recipient.

"This is a message for my young friend, Hudge," it began. "Although at this point, you and I are quite of an age, are we not?" The figure chuckled. "As you see, I am still here, although I may not say exactly where. It is of no importance, in any case." de Waal's image gestured and a comfortable-looking chair moved into place behind him. He sat, reached outside the limits of the recording and leaned back, now holding a bottle. He sipped, then smiled. "Amish birch beer, Hudge. There really is nothing else like it anywhere in the known universe."

Bubba wished for some of his own, but was now reluctant to either leave the room or ask Mike to bring him something. He listened on.

"When the Intelligence you've named Mike contacted me, I was unsure as to what to do. You see, we're not encouraged to make contact with those whom we've left behind, for reasons that should be obvious." The image shrugged. "It is not forbidden, either—little is forbidden, here—but the distances involved make communication with family and friends problematical in the extreme. Without an intermediary, like your Mike, it is all but impossible, and it's vital that Earth remain unaware of the existence of . . ." de Waal gestured with a hand, taking in everything around him. "Well, everything here, and dozens of other places like this scattered all around the galaxy, at least for a little longer."

de Waal took another sip. "Many years ago, when you and I met, Hudge, I was only new in the employ of the Council. My job was simple: to find, and if possible, recruit, humans who were willing and able to comprehend the enormity of the universe around them; who were ready, in my opinion, to make the leap from ignorance to awareness. You struck me as such, but circumstances prevented me from revealing my true purpose to you."

Bubba nodded to himself, recalling with no little pain the untimely death of his younger sister, gone now these forty-eight years, and the chasm it created between him and his family.

"But, since I could not intrude on your grief, and since I could not give you back all that you had lost, I was still able to give you something back—your faith, your belief." Bubba smiled, recalling the UFO he'd seen that night in the desert, flashing and strobing and making weird noises. Yep, that had done it, all right.

"You were, however, well on your way to being one of the more qualified of those I'd encountered over the years, for all your youth and inexperience. So, your name went on a list of those to be watched and kept track of, with the idea of someday approaching you in the open."

"Huh!" Bubba exclaimed, recalling that

Mike had hinted at something of the like back when they'd first met. He wasn't at all sure he liked being on anyone's list, no matter what the reason, but so far this hadn't turned out too badly.

de Waal's image continued. "Rest easy, Hudge. You were not spied on. We merely 'kept tabs,' as you say. Your life was in no way interfered with. However, when a pair of Nishian caseworkers—the ones you dubbed Stan and Ollie, I believe—ran into some minor difficulty with their ship, your name came up." de Waal smiled and sipped his root beer. "I was able to give them a first-hand account of your willingness to help strangers, and so contact was made.

"It was part of our plan to ensure that you had access to information about certain technologies and knowledge of other civilizations. What was unplanned was the manner in which this was made possible. None of us foresaw that you would end up in possession of an Intelligence, nor that it—I suppose I should say 'he'—would become a trusted companion. A friend." de Waal closed his eyes. "This should not have come as a surprise, especially to me. I recall with pleasure how warmly you accepted the friendship of an aging stranger, and your friend Mike speaks of your friendship with great pride.

"I say all that, Hudge, to lead to this: we would like you to join us here. You have shown both an affinity and an aptitude for solving problems, even when they involve aliens, and that talent is highly valuable to us. We need more people who can cope, as you have, with the knowledge that they are not alone in the universe, and for whom that revelation is a cause for joy and not fear." Bubba's breath caught. This was . . . well, it damn sure wasn't anything he'd expected.

"Stop, please." The recording paused, the image motionless. Bubba sat back, trying to take in what he could of this new information. Jesus! What the hell had he gotten himself into fifty years ago in that God-forsaken desert? All this because he fixed some piece-of-crap English bike? It was too much for him right now.

He stood, then walked to the kitchen on legs slightly unsteady. As he figured, Mike was nowhere to be seen. He got a cold bottle of Anchor Steam, then went outside.

The night was clear, the stars almost painfully bright. How many? How many of them had planets, how many of the planets had life, and how many of those were looking up as he was, wondering the same? Was there Another out there somewhere, a retired mechanic perhaps, facing the same doubts he was?

No, he thought. Screw this. It didn't matter how many planets, how many civilizations. It didn't matter if he was the only one staring up at the night sky or one of thousands. That would all take care of itself—or not; either way, it was a meaningless complication. What mattered right now was that he had a message from an old friend and a cold bottle of beer and an intense curiosity that all the burnout in the world couldn't dim. His questions could wait. He went back in the house and sat down at the table.

"Okay," he said, taking a big pull on the Anchor Steam. "Show me more."

The image came back to life. "It is not easy, Hudge, but then you're no stranger to hard work. And there are benefits over and above the obvious ones." de Waal spread his hands. "Look at me. I was born in 1898, and have aged not at all since you and I met. Nor am I likely to fall ill. When I die, it will be because I have chosen to after a productive life, and I will go gently into that Good Night. Plus," the image smiled impishly, "you will have an unlimited opportunity to learn. Here are the finest teachers, the finest facilities, and the perfect surroundings in which to resume your education."

He sighed. "If I have regrets, they are for those I left behind; family, friends, the places and things I may never see again. This should be a factor in any decision you make. I know you were far away from your family all those years ago, and

I know there were circumstances that kept you apart from them." de Waal stood. "If you decide to join us, I urge you to mend what fences you can, and say what good-byes you can. I did not, and I am sorry. I hope to hear from you soon, friend Hudge, and whatever decision you make, I wish you well." The recording ended.

"Well, *damn*. What the hell am I gonna do now?" He sat forward and put his head in his hands. There was too much to take in, too much to think about. He was . . . tired. Tired, old, and full of the pains that tired and old bring.

"You don't have to give him an answer right away, you know," came Mike's voice from the other room. "Everybody knows what your situation is."

Bubba raised his head. *"Everybody?"*

"Well, the ones who needed to know. You were a unanimous choice, by the way, especially after Hoss and his family weighed in." Mike rolled into the room, gripping a piece of paper in his claw. "Don't let me influence you, but I think you could do a lot of good out there. And it would solve our other problem as well."

Bubba sighed, long and deep. "I'm gonna need some time, Mike. I got to think." He sat back, hands against the overstuffed chair arms. He began picking at the frays. "What are my options?"

"Options? Well, one is to turn them down, live out the rest of your life here, and hope for the occasional visitation. You'll probably get a few. Another is to take the opportunity and run with it. You'll live a lot longer, you'll make a difference, and you'll work with races and species you've never dreamed existed. Or," he continued, "you could go hide somewhere and pretend this never happened. I think that about covers the options."

Bubba tapped his fist lightly against the chair arm. "This has always been enough for me, Mike. This right here, in this beautiful state and among these good people. Why would I want anything else?"

"Do you want me to run through your options again? Bubba, I like it here too. There really isn't anything else quite like it anywhere. But that's true of *all* the places, too. There is beauty, some of it just as comfortable and some of it terrible and frightening. There are good people out there, too, even if, in many cases, you can't say their names. But think about this: you've been to the Moon, you've been to another planet. You've shaken hands with aliens and helped them in times of crisis. You've been adopted into a proud and noble clan, one that can and will do everything in their considerable power to help you adjust. Can you ever be really content with King William County after all that, knowing what's waiting for you up there?"

"'How you gonna keep 'em down on the farm, after they've seen Paree . . .'" the Earthman muttered under his breath. He pointed a finger at Mike. "I'm not Roy Neary, Mike, makin' a mountain out of mashed potatoes. I know there's life out there, I've seen it and got drunk with it. What they're asking . . . what *you're* asking . . . is that I give Earth up like Pieter did." He shook his head emphatically. "I don't know if I can do that."

"You'll live, effectively, forever."

"But it won't be *here*, Mike!"

"What was all that you said to me on the way back about 'wonder,' Bubba? You have a chance to study, to associate, to work with the best minds in the Galaxy. How can that not be wonderful for you?"

"Oh, it is, it is, Mike." Bubba sagged. "I just . . . I just can't think about all this right now. I need rest." Wearily, he pushed himself out of his chair. Mike extended his arm, showing him the piece of paper he was holding. "What's that?"

"A phone number for Five Willows Retirement Community."

"And I want this because. . . ?"

"It's where your father lives." Mike managed to shrug with robotic arms. "Whatever you decide, I thought you might . . ."

"Yeah. Thanks," Bubba interrupted. "Great. One more thing to think about." He trudged toward the stairs and climbed them slowly.

Mike placed the paper on the table next to the little square. "Sleep well, Bubba."

"Ain't no other way, Mikey," his friend called down. But sleep didn't come easily that night, and when it did, it was disturbed by dreams he couldn't recall upon awakening. He rose twelve hours later, largely unrested, and full of indecision.

Dressed and breakfasted, he put off the inevitable and went into the living room. The phone number was where Mike had left it the night before. He picked it up and started to wad it up into a ball, but stopped. His hand was trembling, his heart was beating hard in his chest. He sat heavily in his armchair. The slip of paper felt rough against his fingers, and as he held it, the almost imperceptible rustle it made burned in his ears.

Bubba laid it on the table in front of him and stared at it. It was a Virginia area code, but he didn't recognize the exchange. He flicked it with a finger, and it spun lazily in place. "Damn. Damn, damn, *damn.*" Finally, he took the paper in one hand, holding it gingerly, and picked up the phone with the other. He dialed the number, then sat back, listening to the ring. He thought for a moment that there would be no answer, but just as he was ready to hang up, the line clicked. A voice, thin and a little shaky but clear, answered.

Bubba cleared his throat. "H'lo, Pop?"

There was a silence at the other end, then his father said, "Allan! Is that you? It's been so . . . so long, son."

"Yeah, Pop, it's me."

"It's so good to hear your voice, Allan. I've missed you."

"Me, too, Pop. Both of that." Bubba wiped his hand across his brow; he'd always been tongue-tied around his father, and even his age didn't make a difference. "Pop, I'm . . . I'm sorry. So sorry."

There was another silence. "What for, Allan?"

Bubba's hand was shaking now, and he placed it palm down on the table. "For everything. For not being what you wanted me to be, for leaving you and Mom, for fighting with you all those years ago. I'm sorry that I don't call you, don't come to see you. I'm sorry that I let all that silly shit get between us and keep us apart for almost fifty years." His voice was close to breaking, but the words poured out in spite of the constriction in his throat.

"I'm sorry, so very sorry, about Alice, Pop. I'm sorry I let her die."

"No." His father's voice was steady now, and forceful. "Allan, what happened was an accident, plain and simple. You did nothing to be sorry for, aside from calling me a few names I probably deserved to be called. I was a damn fool of a father, and I drove you away just as sure as if I'd done it with a whip." The old man chuckled. "Lord knows your mother told me so often enough."

"Can you . . . can you forgive me, Pop?" Bubba said, his cheeks wet.

"If you can forgive me, son."

Bubba nodded to himself. "We can talk more, Pop, but not on the phone. I can come out there, and we can sit down and talk, and catch up. I can be there in just a few hours—hell, I can be there in five point eight seconds, but I guess I'd better drive." He knew he was babbling, but he couldn't help it; he was so full of emotions that he couldn't tell one from another. "Would that be okay, Pop?"

"I'd really like that, Allan. Take your time, don't rush. We've got all the time in the world. We'll have something to eat, although I'm not the cook your mother was." He paused. "It'll be good to see you, son."

Bubba closed his eyes and let out his breath. The tightness in his chest and throat had eased. "Good, Pop. That'll be really good. See, I got this job offer, sort of a career change, and I need your advice . . ." ■

THE REFERENCE LIBRARY Tom Easton

Time's Child, Rebecca Ore, EOS, $14.95, 327 pp. (ISBN: 0-380-79252-4).

Empire, Orson Scott Card, Tor, $24.95, 351 pp. (ISBN: 0-765-31611-0).

Emperor, Stephen Baxter, Ace, $24.95, 302 pp. (ISBN: 0-441-01466-6).

Unity, Steven Harper, Tor, $25.95, 319 pp. (ISBN: 0-765-31606-4).

The Secret City, Carol Emshwiller, Tachyon, $14.95, 217 pp. (ISBN: 1-892391-44-9).

From the Notebooks of Dr. Brain, Minister Faust, Del Rey, $13.95, 392 pp. (ISBN: 978-0-345-46637-2).

Fast Forward 1: Future Fiction from the Cutting Edge, Lou Anders, ed., Pyr, $15.00, 409 pp. (ISBN: 978-1-59102-486-6).

Things Will Never Be the Same, Howard Waldrop, Old Earth Books, 312 + xii pp., tp $15.00 (ISBN: 978-1-882968-36-7), hb (300 copies only) $45 (ISBN: 978-1-882968-35-0).

The last book by Rebecca Ore was *The Outlaw School* (reviewed here in May 2001), so we have been without her unique view and considerable talents for too many years. But here at last is **Time's Child** for your delectation.

The time is 2308. Earth has been ravaged by plagues that have left cities depopulated, nations fragmented into rival city-states, and the survivors wary of travel and travelers. But the Philadelphia National Archive has been given a time scoop by someone (or ones) in the future. They find that they can remove people from the distant past, but only if they disappeared in a battle or natural disaster or just went missing. Benedetta, a young woman in a Milanese artillery crew who knew Leonardo da Vinci well enough to borrow his gadgets to make toys for her young son, is scooped from a battle just after watching her husband die. Confronted with figures that claim to be angels, she won't have it. After all, who ever heard of an angel with a scab on a knuckle? Soon she knows the truth: The archivists want to pump her about the past and then keep her in a genteel captivity that is nonetheless captivity. Again, she won't have it. She'll take her chances with the vaccines and remnant diseases outside, thank you, and when Jonah—a twenty-first century hacker and troll who stepped outdoors in a blizzard and now claims he thinks he's been revived as a character in a computer game—offers to help her escape the Archive, she grabs the chance. Thanks to knowing someone in her own time who dreamed of the future, she catches on fast. It helps that the political situation—rival city-states—is familiar from her original time, as well.

Ivar is a young Viking scooped from the sea off Iceland. He too catches on fast, and before long he and Benedetta are copying the time machine (with help, of course), listening to conflicting advice from future heads that pop out of windows of blue haze ("Don't bring back the Templars!" "Oh, do, do!"), and concluding that what they do will determine which future becomes actual.

Which hazy head should they listen to? Never mind, for Benedetta has a pretty firm idea that there are a great many past people that deserve another chance, and she and Ivar (and others) start bringing them up. The result is a larger population, cultural and genetic diversity galore, and a forming culture that is actually quite interesting.

Where will it all go? Ore doesn't say, but she doesn't have to. What she does say is enough, for her point seems to be that when people escape dire straits (as do those scooped from the past), they are very appreciative of the second chance, especially when it comes with modern conveniences. There are tensions between old and new, but overall there is a remarkable amount of good will. Old enmities are set aside, new friends are made, and it's time to enjoy life.

If we must speculate on the future of Ore's future, we might reflect on how well people forget. Perhaps it will be less than a generation before those old enmities are remembered, or new ones discovered. And at that point, well, some of these folks from the past are pretty bloody-minded. Or perhaps Ore set her tale in Philadelphia for another reason than the fact that that is where she currently lives. It is after all the City of Brotherly Love.

I think you'll enjoy it.

I don't seem to live in the same world as Orson Scott Card. As he explains the genesis of **Empire** in his Afterword, he was asked to create a novel that would become the storyline of a video game centered on a near-future American civil war. Since he sees a great polarization in America, along the blue state-red state lines the media made familiar in the last election, he then found it fairly easy to imagine how such a civil war might develop. Where do his world and mine differ? I see the polarization, but I don't see it as so dramatic a thing. The difference may be because I live in a part of the country that often seems (at least to me) more reasonable than others. We have Olympia Snowe for a Senator, after all! Or it could be that Card has been bashed by both Left and Right and thereby felt the polarization in a very personal way.

But it doesn't really matter whether Card and I live in the same world. *Empire* is a cracking good read. It opens with a demonstration of Captain Reuben Malich as an honorable soldier. He does well in a difficult mission, is promoted to Major, and is sent to Princeton to hone his intellect. There one of his professors, Averell Torrent, talks a lot about how Rome achieved its true greatness when the Republic gave way to the Empire at a time when civil war loomed and a strong man could bring order out of chaos. Before Malich leaves, Torrent feels him out about his willingness to accept "a covert assignment to help hold this country together."

Before long, Malich is working out of the Pentagon, carrying out missions apparently ordered by someone in the White House. One of those missions involves studying Washington and figuring out just how terrorists could successfully assassinate the President. He assumes the idea is to find holes and promptly plug them, does his usual good job, and hands in his report.

Coleman is assigned to Malich's office as an aide, but finds that Malich is never around. When they finally make contact, it is on an overlook by the Potomac, just in time to spot Malich's plan under way. They do their best, but though they interfere with the plan, it is successful enough to kill the President and others. They are heroes, though Malich expects to be attacked—blamed!—as soon as they find out the assassination plan was his. Before long, Coleman is being invited to join a military coup. He refuses, but it is looking more and more like pre-Empire chaos is setting in. Indeed, a force of Progressive Restorationists, armed with some quite science-fictional weaponry, is now taking over New York City, killing anyone in uniform (cops and firefighters and doormen), and liberal enclaves around the country are rushing to recognize the Progressives as the true U.S. government.

Civil war, anyone? And where's Torrent? He's getting the position of vice-president and looking very presidential as he coordinates the battle of the elected government against the Progressives. He's using Malich and Coleman, sending them out to stymie the foe and eventually announcing that he has tracked down the Progressive headquarters, where the evil mastermind must be hiding. Except that there are signs that the Progressives and the assassins are not the same group.

Meanwhile Malich's wife Cecily is getting very suspicious, for that mastermind as well as far too many other foe figures turn out to have been students of Torrent's.

Is Torrent some sort of master conspirator? That is never clear in the novel, and I have no idea whether the game ever resolves the question. But it doesn't really matter. Card has constructed a very nice conspiracy thriller that is satisfying in its philosophical-historical rationale, the technical ingenuity of the Progressive technology, and its level of derring-do and heroism. In some ways it follows the standard pattern; in at least one way it does not, for a very important character gets killed long before the climax. If you like good characterization, you'll love Card's treatment of Malich, Coleman, and Cecily. Secondary characters are less well developed, but that's pretty standard. Overall, you're gonna love this one.

With **Emperor**, Stephen Baxter begins the "Time's Tapestry" alternate history epic. The tale begins in Britain, 4 B.C., when a babe is struggling to be born and his mother suddenly begins babbling in Latin. Fortunately, one on hand is able to write the words down, and they are clearly a prophecy of events to come as the Romans invade and emperors come and go. However, the last few lines, though they are blatantly familiar to the reader, are mysterious to the characters, for they talk of self-evident truths and human rights.

The babe, one Nectovelin, is full-grown when Claudius invades and shatters what the locals thought was might. His cousin Agrippina winds up going to Rome and her descendants carry the prophecy forward through the centuries as Hadrian's Wall is built and, later, as Constantine tours the western provinces, comes near death, and another babe labors to be born.

So the book is a tour of ancient British history, and as such quite well done. The reader smells the stink and dust and sees the towns and walls and camps when they were new, not ruins. But the prophecy is a mystery that demands explanation. It refers to time's tapestry, thereby inviting the recipients of the prophecy to call the source the "Weaver," and wonder who that man or woman, and what their motives, might be. Is the aim to change history? In what way? Baxter has his characters speculate, but strangely he ignores the prophecy's last line, "O child! Thou tapestried in time, strike home! Strike at the root!"

Nor does he call Nectovelin the Anti-Christ, though the coincidence of timing of his birth, and his location at the opposite end of the known world of the time, could easily warrant that. Instead the characters focus on the birth and development of Christianity, which this volume takes up to about the time of Augustine and the setting of the authoritarian pattern that persists today. But is it this whose root the prophecy calls for striking? Is the change the Weaver seeks religious, or political, or philosophical? Indeed, what would the world be like today if the ideals of the American Declaration of Independence had become established a thousand years ahead of time?

We'll have to wait to see what Baxter's up to, but so far the signs are good.

Now I know why I don't like *Battlestar Galactica*. The premise never convinced me, and the details—machine people that can get pregnant from humans? C'mon!—actively offended my sense of reality. But I picked up Steven Harper's **Unity** anyway.

I wish I hadn't. The very first line—"A trio of Cylon raiders dipped and swooped through space like silent bats on razor wings"—is one of the oldest gaffes of space opera. Not that I need to tell *Analog* readers, but *you don't swoop in a vacuum!* A bit later on (p. 100), it became clear why the Galacticans are having such a tough time licking the Cylons: They proudly admire repairs on the wings of their fighters—repairs made with solder. *You don't solder things that have to stand up to strain!* Solder is weak. Welding works much, much better, and I am not inclined ever again to pick up a book in this series.

With that all said, what is *Unity* all about? The fleet is at rest in a system where they can pluck from a living world gobs and gobs of algae goop for food and medicines. The Cylons attack and are fought off, leaving an escape pod behind. In the pod is Peter Attis, a pop music star who has been a captive of the Cylons since shortly before their initial attack on the Colonies. Despite suspicions, once he has been checked for any viruses or bacteria the Cylons may have loaded him with, he is accepted. Before long, he gives a concert to a massive audience, and shortly after that people start falling ill with something a bit like Mad Cow Disease. Victims start twitching, speak in tongues, lapse into coma, and finally die. The frantic search for a cure is complicated by religious nuts who decide Peter is the prophesied Unifier and the disease is a blessing. But of course the search is successful; we know that from the git-go since right at the beginning of the book it says the tale takes place between two episodes of the TV show.

There are all the usual soap-opera details, of course. Not one of them does a better job of convincing than using solder on strain-bearing wing cracks.

Bah.

Carol Emshwiller has been earning praise for a long time, and at 85 she's not done. Her novel **The Secret City** is a charming take on the "aliens among us" trope that begins when a homeless man is arrested. His primary offense is snoring under a bush in an old lady's back yard; his secondary offense is rather bruisingly resisting arrest. He's a beefy fellow, you see, and it takes but a few pages for his interior monolog to reveal that he is an alien. His parents were tourists come to Earth to gawk at the pitiful natives. Their disguise was flowered shirts and shorts and cameras beyond which the natives just wouldn't look to notice the bulky bodies and brow ridges.

I suppose that could work, as long as the tourists weren't too different from us, and these weren't. In fact, they looked pretty human, or at least Neanderthal (those brow ridges, right?), so they could pass. But when they weren't retrieved according to plan, they had a problem. Mostly they kept on wandering the landscape dressed like tourists, though the flowered shirts got pretty tattered once they ran out of money. A few retreated into the mountains, where in an isolated valley they built a kinda-sorta reminder of home. They had to keep the profile low to escape notice from planes and satellites, but they could build an urbanish architecture that—they hoped—would keep the kids connected to home. And they clung to the hope that someone would show up to rescue them.

Our vagrant, Lorpas, escapes and, looking for his possessions, winds up befriending the old lady who ratted him out. Alas, when the rescuers arrive, they kill her. He runs, heading for the mountains, searching for the rumored Secret City. In due time, he finds it, as well as the last three of his kind, one of them a young woman, Allush, with whom he is quickly smitten, as is she. Alas, one of the others is a bloodthirsty nutcase who thinks Allush should be his. The third is a wise old woman who had been a peasant.

Does that matter? The rescuers show up again and snatch Allush away. She soon learns that it matters indeed. Home is a strange world where the food and water taste weird and appearance matters greatly. Can she go home again? Which world is home? Is there a place for her and Lorpas on either one?

That last is a question Lorpas is working on, too. The answer is perhaps inevitable, but Emshwiller does a very nice job of developing it. Her characters are quirky and genuine, and the tale is a warm one punctuated by death and loss. I enjoyed it greatly, and I think you will too.

One does not have to do a Ph.D.-equivalent of research to realize that the superhero comics have long reflected the concerns of the real world, from fighting Nazis and Communists to racism and feminism, nor to realize that both heroes and the villains they fought were nuts enough to make a violent ward look sane. Does this mean someone should turn a shrink loose on them? In *Superman on the Couch* (reviewed here in October 2004), Danny Fingeroth spent as much time psychoanalyzing the reader as the heroes. Minister Faust is more to the point in **From the Notebooks of Dr. Brain**, in which Eva Brain (the echo of Eva Braun is surely deliberate, given her tendency to coin Germanically polysyllabic hyperbafflegab at the turn of a page), official shrink for the Fantastic Order Of Justice and its FOOJsters (which I persist in reading as FOO Jesters!) attempts to induce Omnipotent Man, Flying Squirrel, Iron Lass, Brotherfly, Power Grrl, and X-Man to conquer their Secret Identity Diffusion, mortiquaeroticism, Racialized Narcissistic Projection Neurosis, and so on to achieve psychemotional wellness and cut out the infighting that threatens FOOJ's continued existence. Unfortunately, Hawk King, ancient master of superherodom, dies in his sanctuary and thus awakens a perfect storm of conspiracy theories, backbiting, and even rebellion.

I suspect Faust grew up on superhero comics and retains a certain fondness for them. But that hasn't stopped him from writing a biting, over-the-top send-up of the genre, self-help pop-psych, celebrities, and more. Unfortunately, he chose Dr. Brain as his narrator, with the result that much of the book is as unreadable as the self-help pop-psych he parodies. Yet for those who make it to the end, there is a very interesting volte-face that suggests that Faust has his own conspiracy theory to explain what has been happening in Washington over the last few years.

But that's not enough to make me look forward to his next.

Lou Anders offers **Fast Forward 1: Future Fiction from the Cutting Edge** in the spirit of Damon Knight's long-missed Orbit anthologies of original fiction. He lives up to that spirit, too, for he has picked twenty-one excellent pieces by Mike Resnick and Nancy Kress, Gene Wolfe, Robert Charles Wilson, Kage Baker, Elizabeth Bear, Ken MacLeod, Paul Di Filippo, and more.

I hope Anders has the chance to continue this series for many volumes. So will you when you get a taste of it.

Howard Waldrop has been writing SF a bit longer than I have and is quite justly many times as well known. His marvelously quirky "The Ugly Chickens" alone is enough to make a writer famous even if that writer never penned another tale, and Waldrop has sprinkled tales just as marvelous and just as quirky by the dozen on his devoted admirers. It is thus a tragedy that he is not as wealthy as, say, Stephen King, or as bedecked with medals, awards, and other honors as a Ruritanian prince. He says about as much in his introduction, but of course Waldrop being Waldrop, you are never sure how much of what he says with such a straight face you should believe.

Be that as it may, his stories have a tendency to make you see the world in new ways. Indeed, the title of his new book has a definite aptness, so order **Things Will Never Be the Same: Selected Science Fiction, 1980-2005** right away. You'll get a bunch of Hugo nominees (more tragedy—someone always seems to beat him out!), of which the latest is "The King of Where-I-Go," which is so sure to make you unsure of your own past that Waldrop might as well hit you in the forehead with a croquet mallet (that's a clue, Bubba). I also quite loved the Runyonesque "The Sawing Boys," in which Prohibition-Era gangsters meet country music, as contaminated by early radio. Sixteen stories altogether, and not one you'll be sorry to have read.

Enjoy! ■

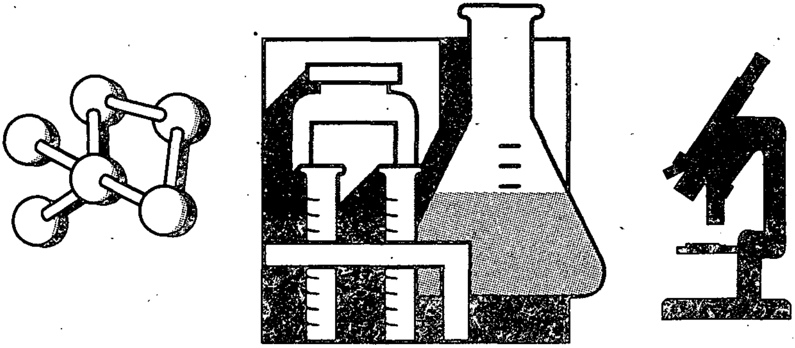
IN TIMES TO COME

David A. Hardy's spectacular cover for our September issue heralds "Some Distant Shore," Dave Creek's tale of a cataclysm even more spectacular than any art can truly convey: the collision of two solar systems. Granted, that's an event that unfolds over quite a long time scale, but its crucial moments make for an intensely dramatic story—especially when they attract an audience of representatives from several quite alien species and cultures, all as intent on studying (and exploiting) each other as the astronomical show unfolding before them.

We'll also have "Vertex," the climactic story of C. Sanford Lowe and G. David Nordley's "Black Hole Project" series, in which everything comes together (or does it?), and stories by E. Mark Mitchell, Uncle River, Richard A. Lovett, and Howard V. Hendrix.

Finally, Edward M. Lerner's fact article, "Beyond This Point Be RFIDs," is unusual in that most of its science-fictional content is already upon us—but its implications extend far into the future, as will heated controversy over what those implications can and should be.

THE ANALYTICAL LABORATORY



Thanks again to everyone who voted in our annual poll on the previous year's issues. Your votes help your favorite writers and artists by rewarding them directly and concretely for outstanding work. They help you by giving us a better feel for what you like and don't like—which helps us know what to give you in the future.

We have five categories: novellas, novelettes, short stories, fact articles, and covers. In each category, we asked you to list your three favorite items, in descending order of preference. Each first place vote counts as three points, second place two, and third place one. The total number of points for each item is divided by the maximum it could have received (if everyone had ranked it 1) and multiplied by 10. The result is the score listed below, on a scale of 0 (nobody voted for it) to 10 (everybody ranked it first). In practice, scores run lower in categories with many entries than in those with only a few. For comparison, the number in parentheses at the head of each category is the score every item would have received had all been equally popular.

NOVELLAS (2.50)

1. "The Good Kill," Barry B. Longyear (3.95)
2. "Puncher's Chance," James Grayson & Kathy Ferguson (2.78)
3. "A Pound of Flesh," Richard A. Lovett (2.72)
4. "The Little White Nerves Went Last," John Barnes (2.53)
5. "Kremer's Limit," C. Sanford Lowe & G. David Nordley (2.28)

NOVELETTES (1.18)
1. "Lady Be Good," John G. Hemry (2.26)
2. "Dinosaur Blood," Richard A. Lovett (1.85)
3. "Takes Two to Tangle," Ben Bova (1.73)
4 (tie) "Original Sin," Richard A. Lovett (1.37)
"String of Pearls," Shane Tourtellotte (1.37)
"From Wayfield, From Malagasy," Robert J. Howe (1.37)

SHORT STORIES (0.71)
1. "Kyrie Eleison," John G. Hemry (1.83)
2. "Nigerian Scam," Richard A. Lovett (1.78)
3. "The Door That Does Not Close," Carl Frederick (1.61)
4. "Mop-Up," Grey Rollins (1.39)
5. "Total Loss," James Hosek (1.22)

FACT ARTICLES (1.82)
1. "The Great Sumatran Earthquakes of 2004-5," Richard A. Lovett (2.97)
2. "From Fimbulwinter to Dante's Hell:
The Strange Saga of Snowball Earth," Richard A. Lovett (2.83)
3. "Solar System Commuter Trains: Magbeam Plasma Propulsion,"
James Grayson & Kathy Ferguson (2.10)
4. "Pollution, Solutions, Elution, and Nanotechnology,"
Stephen L. Gillett, Ph.D. (1.88)
5. "Floatworlds," Stephen L. Gillett, Ph.D. (1.52)

COVER (2.00)
1. September, by Jean-Pierre Normand (2.76)
2. November, by Jean-Pierre Normand (2.56)
3. December, by Mark A. Garlick (2.24)
4. June, by Jean-Pierre Normand (2.18)
5. March, by Jean-Pierre Normand (1.86)

This year all categories had clear winners, but there were as usual some interesting patterns among the contenders. John G. Hemry had the unusual distinction of placing first in two categories, Richard A. Lovett captured the top two spots in fact articles and had at least one story in the winners' circle for every fiction category, and Jean-Pierre Normand won four of the top five cover slots. We had a three-way tie for fourth place in novelettes, and several newcomers made strong showings: James Hosek with a short story that drew an unusual amount of reader comment, and James Grayson and Kathy Ferguson with a linked story and fact article in the same issue.

Since Anlab votes are so useful to everyone concerned, we hope to get even more next time. Use e-mail or "snail mail," whichever you prefer, but please vote! (Please be careful to vote in the right category, as listed in the annual Index. Sometimes a few votes are wasted by being cast in the wrong category, and those simply can't be counted. If you didn't use the online voting on our website [www.analogsf.com] this year, you might want to try it next time; it makes that problem virtually impossible!)

Pete Bullock of Charlotte, NC, is this year's winner of a free one-year subscription in a random drawing from all ballots received. Next year that could be you—and the more votes we have, the more the results mean!

BRASS TACKS

Dear Mr. Schmidt,

When I worked 8 to 6 ("9 to 5" certainly is a euphemism now, isn't it?) I used to read at lunch and kept up with my monthly *Analog* and *Asimov's*, and sometimes even a Hugo novel winner or two. When my husband became ill, and then passed this last year, my daily schedule became chaotic and remains so.

This morning I decided to take the time to eat breakfast out and grabbed an unread *Analog* to take with me.

I tend to read cover-to-cover, but more and more am evolving into a "read the editorials first" SF-type person. I once again delighted in your viewpoint and your style. I have never written an editor a letter, tho' I certainly have an opinion. Yet you moved me to think a step further and to desire to add to the conversation. Although I can join any conversation (I hope intelligently), rarely are there conversations intelligent enough to feel "moved" to add to.

I hurried home to write my letter before I let other things demand my time, and as I looked closer to reference the article, I saw that "Attack of the Giant Oxymorons" was a November 2004 issue. My! Aren't *we* behind!

Well, for me the conversation was new, but for you it is a time warp, so, suffice it to say, I treasure your wisdom, your thoughtfulness in your communication, your courage in front of a sometimes schizophrenic public, and your willingness to share yourself with us. You improve my life.

Ms. Renee Taylor
Kagel Canyon, CA

Dr. Schmidt:

I read your editorial on the anthropocentric principle (Jan/Feb 2007) and immediately thought of "Candide." So some people think that this universe is designed especially for us? Well, I think it's too bad we ourselves weren't designed with more care. How any rational person can scrutinize the human body and conclude it is the height of creation is beyond my comprehension. A case of willful blindness. A few keywords—scoliosis, scurvy, appendix, caries, allergies, slipped discs, hernias, cancer, gender fuzziness. These all seem to me things that truly intelligent design would have prevented.

Walt Bjorneby
Lt/Col, USAF (ret ftr plt)
ASF reader since 1944

Dr. Schmidt:

It seems I was a little hasty in responding to your "Anthropocentric" editorial. I just arrived at "The Letters to the Editor" and the first four really rang my bell. I suppose it is comforting to a lot of people to think that there is a loving, caring Deity watching over their every move, and that they were personally created in His image. The seemingly never-ending series of wars we have experienced have dissuaded me of this view if I ever thought that way, which I doubt. I'll have logged 76 years in this vale of tears before your next issue is out, and after a recent weeklong visit with my highly learned brother-and sister-in law, we all came to the conclusion we are deists. Until somebody comes along with a sound explanation of the creation of our cosmos, what else are we supposed to think? Here is the true miracle as I see it—from as little as three independent particles, our entire universe sprang into being and from the interactions of these particles over a span of perhaps 14 billion years—here we are, with all our faults and our beauties. (I posit three, purely for sake of the Law of Parsimony.) Bye the bye, I cannot comprehend how anyone with a knowledge of the human body's shortcomings can imagine that we were created by Someone Who knew what He/She/It was doing. Certainly every woman should view the bony-ringed human birth canal with great skepticism as to its Deistic origin. It, like much else amiss with our body design, is quite obviously a scrap-basket hand-me-down from our forebears. The human foot, knee, wrist, spine, appendix, tonsils, adenoids, sinus cavities, teeth, all reflect major faults in design. We, alone of all animals as far as I know, are the only species who cannot drink and breathe at the same time. And we, unlike most other animals, cannot manufacture our own Vitamin C, hence scurvy, a truly horrible deficiency disease . . . tsk, tsk. Oh, I almost forgot; a brain that lets emotion flavor its reasoning. Our body rates a big half-black spot from Consumer Research. Possibly continued evolution shall result in design corrections if the species lasts long enough. Happy New Year, I trust.

Walt Bjorneby
Lt/Col, USAF (ret ftr plt)
ASF reader since 1944

Dear Dr. Schmidt,

I've just read your delightful, though risky, editorial "The Cheesesteak Nazi, The Colonel, and the Food Police" in the Jan/Feb *Analog*.

I've often remarked that Western Civilization has been conducting a gigantic, uncontrolled genetic experiment for about 200 years. Don't worry; Charles Darwin still gets the last laugh.

Global warming as practiced by 6.5 billion people is far more than 6.5 times more deleterious than global warming practiced by 1 billion people. Paul Ehrlich long since said something to the effect that, at root, every major problem you see around you is the consequence of over-population.

A recent study here in Australia showed that 25% of national medical expenditure went to the last 18 months of patients' lives without extending those lives or improving their quality.

I imagine that when the crunch comes, medical support schemes for the "unworthy" will be among the first casualties. I was born in 1946 and anticipate that the definition of triage will be much extended by the time that I need serious medical support. "Euthanasia, or the door is that way . . ."

Throughout the history of mankind and in some places today, speaking the "wrong" language has distinct life-shortening potential. I hope that I don't live long enough to see that one.

John Jenkins
Sydney, Australia

Dear Stan,

I have just finished your editorial ("New Writers") in the March 2007 issue of *Analog*. I strongly agree with you. One of the primary reasons I subscribe to *Analog* is to discover new authors. I can still remember reading "Ender's Game" by Orson Scott Card and looking forward to more of his works. Then there was Joe Haldeman's "The Forever War," which was first published in *Analog* as a series of stories. I eagerly awaited each new story and, eventually, the novel. Among the other authors I follow are Amy Bechtel, Catherine Asaro, and Lois McMaster Bujold.

Keep up the great work.
Henry H. Werner
Naperville, IL

Dear Mr. Schmidt,

Thank you for the candor of your March 2007 editorial on new writers. I am one of those, and two of my stories got turned down. I could understand you turning them down . . . if you had nothing better. Then I read the two you chose and wondered, who's kidding who?

I told the superintendent of the building where I live, "This guy Schmidt, the editor of the magazine, tells all his readers that he can't buy more than 1% of the submissions. So all the new writers know that, even if their work is totally publishable, the odds are so frighteningly stacked against them, they may as well not waste their time and postage. It's like paying the editors to turn you down. You're better off adapting the piece to a novel length, and sending the sample chapters and outlines to major book publishers. Or, just pay for the magazine space, as if you're buying an ad. I wish there was some way to cut the flow of submissions to nothing, and watch Schmidt try to write the magazine himself. Maybe he'll turn himself down."

Did I write this just to bitch? Not exactly. I just wanted to reiterate, in my own way, what you already told your readers: "99% of all writers get turned down, and it may have nothing to do with the quality of the piece! We can't buy more than 1%! So, why are you killing yourself on our magazine? You want to get bought out by a major New York book publisher? Just send your stuff right to them! Why let us kick you in the ass at your expense? Are you crazy?"

Is this what you wanted to say in your editorial? Because you sure said it to *me*.

In case you were wondering (you probably weren't), I *do* have other sci-fi pieces, and I lack the masochism and stupidity to send them to you at my expense. I wish you the best of luck in ending up with the kind of writers who *are* dumb enough. From what you already ran, it looks like you're getting them. They all need business managers, and perhaps psychiatric help.

Larry Cohen
Cleveland Heights, OH

I'm sorry you didn't understand the editorial, but if that's what you think I said, you couldn't have missed the point more completely.

It isn't random! If you can learn to do the kind of thing our readers will like, better than 99% of the others trying, your chances of a sale are much better than 1 in 100. If you can't, they're much worse.

And you think your chances are better at a book publisher? Just try it. Most of them won't even look at your submission unless it comes through an agent they trust. We will, and with genuine interest.

As for your stories being as good as the ones we published, that's not inconceivable—but it's not likely, either. Writers often think much more highly of their work before they've gotten really good at it than after. Self-critical skills are apparently among the last to develop.

It is a highly competitive field, and if you can't deal with that, it is not the field for you. Writers have to be persistent and thick-skinned. The skills can be learned, and some people do so. But nobody ever did it by giving up after two disappointments and diverting his energy into rants about sour grapes. That's the surest way to be absolutely sure you won't sell anything.

And just for the record, I have turned myself down. ■

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UPCOMING EVENTS Anthony Lewis

1–3 June 2007
CONCAROLINAS 2007 (Carolina area SF conference) at Marriott Executive Park, Charlotte, NC. Guests of Honor: Barbara Hambly. Elaine Cunningham, Teri Wachowiak, Robert Buettner. Info: www.concarolinas.org; concarolinas@concarolinas.org; ConCarolinas, Box 9100, Charlotte NC 28299-9100.

22–24 June 2007
COUNTERPOINT (Northeast Filk conference) at Woodfin Suite Hotel, Rockville, MD. Guest of Honor: Wild Mercy; TM: John Hall; Interfilk Guest: Seanan McGuire. Registration: $45 until 31 May 2007; $55 at the door. Single day rates will be available at the door. Info: http://www.filker.org/counterpoint/; sbrinich@speakeasy.net; 5911 Veranda Drive, Springfield, VA 22152.

5–8 July 2007
READERCON (Literary-oriented SF conference) at Burling Marriott, Burlington, MA. Guests of Honor: Lucius Shepard, Karen Joy Fowler; Memorial Guest of Honor: Angela Carter. Registration: $40 until 15 June 2007. Info: www.readercon.org; Post Office Box 38-1246; Cambridge MA 02238-1246.

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30 August–3 September 2007
NIPPON 2007 (65th World Science Fiction Convention) at Pacifico Yokohama, Yokohama, Japan. Guests of Honor: Sakyo Komatsu and David Brin. Artist Guests of Honor: Yoshitaka Amano and Michael Whelan. Fan Guest of Honor: Takumi Shibano. Registration: USD 220; JPY 26,000; GBP 125; EUR 186 until 30 June 2007; supporting membership USD 50; JPY 6,000; GBP 28; EUR 45. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. This is only the third time Worldcon will be held in a non-English speaking country and the first time in Asia. Info: www.nippon2007.org; info@nippon2007.us. Nippon 2007/JASFIC, 4-20-5-604, Mure, Mitaka, Tokyo 181-0002. North American agent: Peggy Rae Sapienza, Nippon 2007, PO Box 314, Annapolis Junction, MD 20701, USA. UK agent: Mike Rennie, 68 Crichton Avenue, Burton Stone Lane, York, Great Britain YO30 6EE (sparks@lspace.org). European agent: Vincent Doherty, Koninginnegracht 75a, 2514A Den Haag, Netherlands (VJ1709@hotmail.com). Australian agent: Craig Macbride, Box 274, World Trade Centre, Victoria, 8005 Australia (nippon07@f8d.com).

1–4 November 2007
WORLD FANTASY CONVENTION at Saratoga City Center and Saratoga Hotel & Conference Center, Saratoga Springs, NY. Guests of Honor: Carol Emshwiller, Kim Newman, Lisa Tuttle; Special Guests of Honor: Barbara & Christopher Roden, George Scithers; MC: Guy Gavriel Kay. Registration $135 until 31 March 2007, $35 supporting. Info: http://www.lastsfa.org/wfc2007/; World Fantasy 2007, Post Office Box 1086, Schenectady NY 12301. ■

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